MACHINE DESIGN

PARTS • MATERIALS • METHODS • FINISHES

THE PROFESSIONAL JOURNAL OF CHIEF ENGINEERS AND DESIGNERS

Volume 9 JUNE 1937 Number 6

EDITORIAL STAFF

Editor
L. E. JERMY

Associate Editors
Guy Hubbard
Fred Kelly
F. H. Burgess

New York . . . . . B. K. Price
Chicago . . . . . W. G. Gude
Pittsburgh . . . . . D. R. James
Detroit . . . . . A. H. Allen
Washington . . . . . L. M. Lamm
London . . . . . Vincent Delport

BUSINESS STAFF

New York
J. F. Ahrens, *Eastern Mgr.*
Russell H. Smith

Chicago
H. H. Dreyer, *Western Mgr.*

Cleveland
H. B. **Veith**, *Central-Western Mgr.*

Published Monthly by
THE PENTON PUBLISHING CO.
Penton Building, Cleveland, Ohio

John A. Penton . *Chairman of Board*
E. L. Shaner . *President and Treasurer*
J. R. Dawley . . . . *Vice President*
G. O. Hays . . . . *Vice President*
F. G. Steinebach . . . *Secretary*

BRANCH OFFICES

New York . . . . 220 Broadway
Chicago . . . Peoples Gas Building
Pittsburgh . 1650 Koppers Building
Detroit . . 1010 Stephenson Building
Washington . National Press Building
London . . . . . Caxton House, Westminster, S. W. 1

CONTENTS

Page

Build-In Your Instruments 29
By Guy Hubbard

Scanning the Field for Ideas 32

Chrome Plating Combats Wear 34
By Fred Kelly

Control Is Simplified with Hydraulics 37
By A. M. Wasbauer

Exhibition Discloses Progress in Foundry Machines . . . 39

Necessary Qualities Found in Rubber Springs 40
By C. F. Hirshfeld and E. H. Piron

Plastic Model Facilitates Telescope Design 44

Aircar Points to Auto of Future 45

Inertia Forces Must Be Known for Engine Balance . . . 46
By George L. Guillet

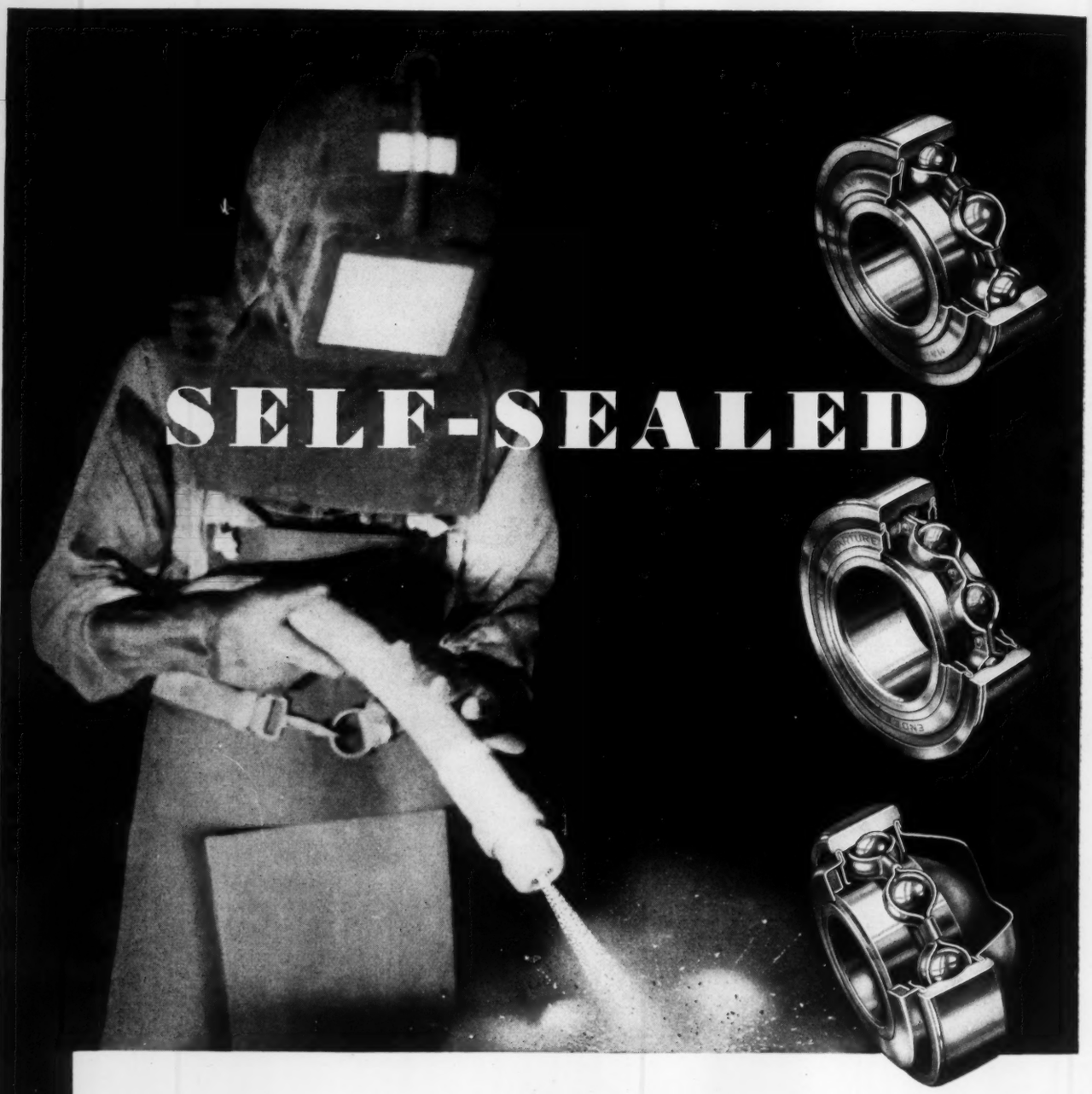
Design Features in New Machines 50

New Machines Indicate Design Trends 52

Will Television Be the Next Industry to Stimulate Prosperity? (Editorial) 53

Professional Viewpoints 54
Men of Machines 56
Noteworthy Patents 62
New Materials and Parts 66
Calendar of Meetings 90
Manufacturers Publications 95
Business Announcements 98
Topics 26

MACHINE DESIGN is published on the tenth of each month. Subscription rates: United States and possessions, Canada, Cuba and Mexico, two years $5; one year $3. Single copies 35 cents. Great Britain and other European countries, one year $5. Copyright, 1937, by The Penton Publishing Co. Acceptance under act of June 5, 1934, authorized July 20, 1934.



SELF-SEALED bearings — a New Departure invention of *9 years ago* — are perhaps the most important development of recent years. That 7 *million* N-D-Seals have been used proves their acceptance — and their value to all industry.

N-D-Seals have saved money for thousands of companies. Find out what they will do for you. Come to Sealed Bearing headquarters — New Departure Division General Motors Corporation, Bristol, Connecticut. Branches at Detroit, Chicago and San Francisco.

NEW DEPARTURE

PIONEER OF SELF-SEALED BEARINGS . . .

N-D-Seals

PHOTOGRAPH COURTESY PANGBORN CORP.

2514

MODERNIZE WITH

VICTOPRENE OIL SEALS

MORE AND MORE MODERN MACHINES ARE BEING EQUIPPED WITH MODERN OIL SEALS

. . . . . as MODERN as tomorrow . . . . . NOW YOU can obtain Oil Seals that give you BETTER PERFORMANCE . . . that meet the needs of MODERN Machines . . . that fill YOUR REQUIREMENTS of Speed, Temperature and Long Life Service.

. . . because every element of the advanced, Victoprene Oil Seal is MANUFACTURED accurately and scientifically. Controlled Precision . . . Better Performance . . . is built in every stage of Victoprene production . . . There is no seal like VICTOPRENE.

"Believe me . . . here is a sealing element that is sure BONDED to the shell. Held firm. Made EXACT. No oil can leak thru the structure of this Oil Seal. Just test it yourself!"

PATENTS PENDING

Look for these Features

VICTOPRENE GIVES YOU—

1. Constant accuracy of all dimensions.
2. Lubricated face for reduced friction.
3. A leak-proof structure.
4. Better resistance to oil, heat, and age.

Complete information on this modern product sent on request.

VICTOR MANUFACTURING & GASKET CO.

"World's Largest Gasket Manufacturer"

P. O. BOX 1333 • 5750 ROOSEVELT ROAD, CHICAGO, U. S. A.

TOPICS

CAMERAS, field glasses and other instruments or machines utilizing expensive lenses may sell for a fraction of their present price if experiments with plastic lenses prove successful. A 32-year old Belgian by birth but British by education and citizenship, Peter Koch de Gooreynd, has already produced lenses of a resinous substance which may be dropped or hammered with a mallet without damage. The material may be molded at the rate of 1500 lenses an hour which would reduce the cost of a $50 camera lens to about $2. No expensive grinding or polishing is necessary.

♦ ♦ ♦

Speaking of plastics, we note that a new plastic molding machine now turns out plastic articles at the rate of "hundreds per minute" rather than "hundreds per hour." The molding machine is a modification of a heavy duty rotary tableting machine such as used for making pills, tablets and small candies. The operation of the new machine is entirely automatic, contrasted with the previous practice in which the press had to be held open for filling mold cavities by hand, closed and then opened for ejection. The molding composition is now fed in to a hopper in granular form and continuously converted to a series of molded pieces which are shot out with machine gun rapidity. Bottlecork tops have been produced at a rate of 600 per minute, according to the Industrial Bulletin of Arthur D. Little, Inc.

♦ ♦ ♦

Started in Detroit a few years ago, the unionization of engineering department staffs is now spreading to other cities. The movement has been slow until recent months, when activities of the CIO in the automobile and other industries have given it added impetus. Draftsmen made up the membership entirely at first, but some chief draftsmen, designers and other members of the engineering department are now included. It is hard to guess how rapidly the movement may develop if it gets thoroughly under way.

The development of a new machine at a crucial time has saved the world on several occasions from a business slump. Today science and industry are combining to obtain new products from agriculture. At a recent meeting of the Farm Chemurgic Council in Dearborn, Mich., papers were read describing experiments to make paper from flax and hemp, plastics from corn, and the refining of oil from fatty waste products. All of these operations require new machines, some only slightly changed from present models, but others original in design. A wide and lucrative field is open for the designer who can build a machine that will aid in obtaining new materials from farm products.

♦ ♦ ♦

Contrary to popular opinion, rubber is not waterproof. It disintegrates into a soft, mushy substance when exposed to moisture for long periods. Recent experiments by two Boston, Mass., chemists have resulted in the discovery of a method of waterproofing rubber so that it can be used as an insulating material for ocean cables and underground power lines which are ordinarily protected by lead. We must confess we were under the impression rubber was one of our best materials for protection against moisture or dampness. However, if it can now be made more waterproof its value to the machine manufacturer should be that much greater.

♦ ♦ ♦

Motorists who pull a heavy trailer behind their autos and believe that it costs them little in fuel economy are kidding themselves, is a contention of James H. Booth, Buick Motor Co. Mr. Booth stated at a recent meeting of the S.A.E. that the load imposed by a trailer on an auto is equivalent to that of a 20-passenger bus. He points out the necessity for trailer and auto manufacturers to get together before serious difficulties arise which will get both into trouble. On another page of this issue of MACHINE DESIGN is a description of a novel vehicle which combines the auto and trailer in one.

MACHINE DESIGN

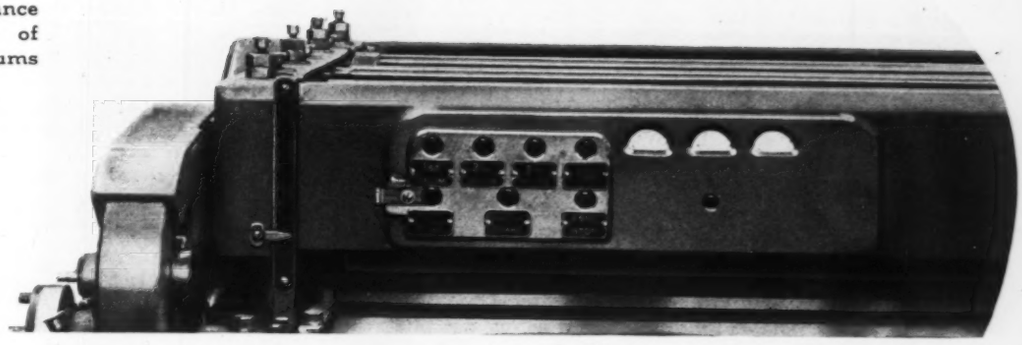
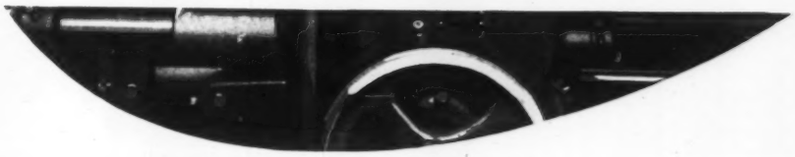


Fig. 1—Ammeters in control panel of multiple drum sanding machine indicate performance and condition of each of the drums

Build-In Your Instruments!



By Guy Hubbard

THAT instrumentation of machinery is one of the most significant of design trends is obvious to those who have made a study of present-day design. This trend toward instrumentation is due to some extent to the broadening applications of electrical drive and control, and of hydraulic and pneumatic principles—all of which are highly adaptable to simple and effective instrumentation. Another important reason is that under modern production conditions it is necessary to know at all times exactly what a machine is doing and how well it is doing it.

For instance, when a high-production machine tool is equipped with cemented carbide tools it must be operated at or close to its peak ability in order to give its peak efficiency, but at the same time over-speeding even to a small degree will ruin the work and the tools, and very likely will wreck the machine. Only through proper instrumentation can this peak be held and performance constantly watched with minimum effort on the part of the operator. No one today would think of operating a steam power plant, an automobile, a chemical process, or even a heat treating department worthy of the name, without the help of instruments, even though there was a time when it was done without them—but with constant danger and uncertainty.

The history of instrumentation of industrial machinery has followed and still is following a course

similar to that of electrification. Electrification began with the use, on equipment such as woodworking machinery and machine tools, of standard motors and controls designed for general power purposes. They were not at that time in keeping with the machines to which they were applied and when "hung onto" these machines the general effect was far from pleasing. Nor was this electrical equipment in keeping with the machinery from the engineering point of view, even though its application was a step in the right direction. The history of electrification in brief has been this: First, the electrical equipment was modified to be more nearly right in its technical characteristics; second, it was modified to look better when "built-onto" industrial machinery; third, it was modified to enable it to be "built-into" this machinery —a design process which still is actively underway; and fourth, controls have been centralized at the strategic operating points.

Practical Examples of Instrumentation

Without attempting to cover exhaustively either the selection of instruments or their application, a brief review will now be made of some cases in which built-in instrumentation of industrial machinery has been accomplished with neatness and with desirable practical results. While machinery builders are inclined to make their own direct reading scales and dials for the setting of slides, selection of speeds and feeds, etc., it is noticeable that instruments for the measurement of air and hydraulic pressure, temperature, electrical current consumption, and for counting, usually are purchased from companies specializing in the manufacture of such instruments. The mounting panel, however, is quite frequently designed and built by the machinery manufacturer—particularly when the instruments really are worked in as an integral part of the design.

An effective combination control and instrument panel is shown in *Fig.* 1. This is built into the frame of a Yates-American multiple drum sanding machine. This machine has a series of three adjustable abrasive-covered drums, although the number sometimes runs as high as eight. The first drum, which is covered with coarse grit, removes the marks of the previous planing operation, while subsequent drums—each one coated with finer grains—progressively wipe out the sanding marks.

In the past, setting of these drums has largely been guess-work, an experienced operator judging the cut of each drum by sound and by appearance of the finished stock. In the machine shown each drum has its individual motor drive and for each motor there is an ammeter on the instrument panel. Normally, motor current does not flow through these ammeters, thus avoiding the high starting currents. When a reading is desired, a button on the panel is pushed. This operates a magnetic switch, diverting the motor current through the ammeter, thereby showing the exact motor load. This gives a definite indication of the nature of the cut and the condition of the abrasive paper, without stopping the machine.

Operation of the special purpose Ingersoll milling machine, of which a motor control panel is shown in *Fig.* 2, involves both portable and stationary master control stations. This machine employs motor-operated field rheostats for remote control of spindle and feed speeds. Tachometers give direct indications of the speeds and "Increase" and "Decrease" pushbuttons are used to vary the speeds through the medium of motor-operated rheostats.

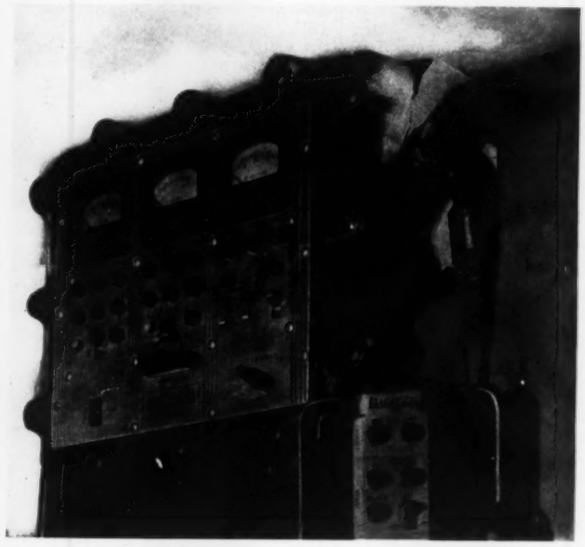
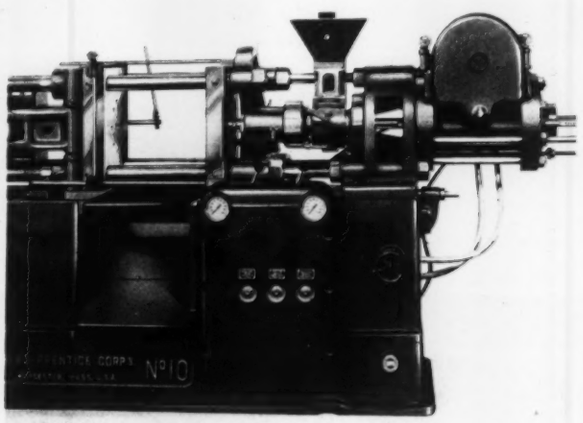


Fig. 2—Tachometers are used on special purpose milling machine to indicate speed of the spindles

Fig. 3—Hydraulic plastic molding machine has built-in gages showing die and plunger pressures



Plastic molding is an operation demanding careful adjustment and maintenance of temperature and pressure. A Vickers equipped automatic hydraulic injection machine developed by the Reed-Prentice Corp. appears in *Fig.* 3. The built-in gages indicate die pres-

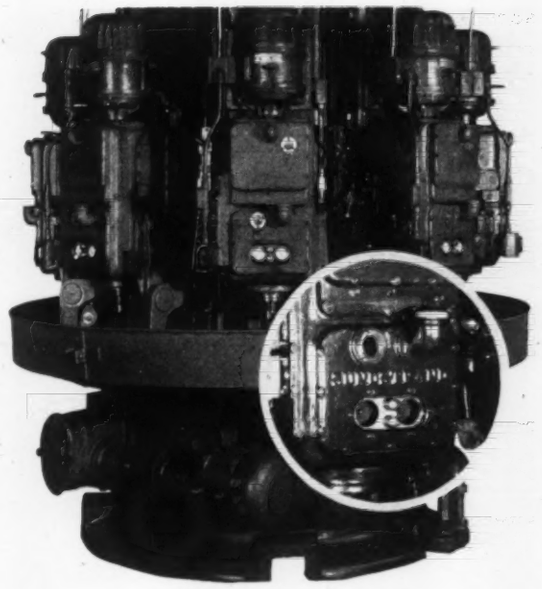


Fig. 4—On this multiple station vertical lathe gages are built-in at each station to register the pressure exerted by the hydraulic chuck jaws

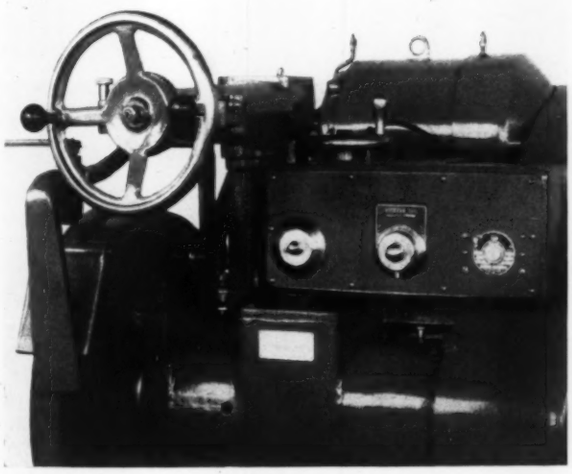
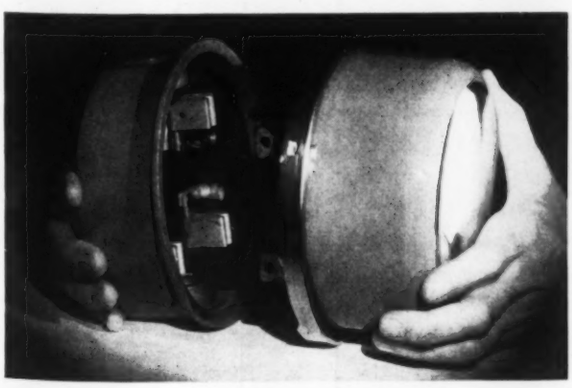


Fig. 5—A telechron clock unit is used on this hydraulic grinder head to govern amounts of dwell

Fig. 6—Instruments of "plug-in" type allow quick removal and replacement, with built-in sockets



sure (left) and plunger pressure (right). The machine also can be equipped with a Brown pyrometer for automatic control of the temperature of the cylinder, which is heated electrically.

The three dials visible below the gages provide settings for the automatic time cycle; that at the right regulating the time the plunger remains forward, that in the middle the time the dies remain closed after return of plunger, and that at the left the time the dies remain open at the end of the cycle.

The photograph reproduced as *Fig.* 4 depicts an eight-spindle vertical lathe built by Sundstrand Machine Tool Co. Hydraulic actuation of the chuck jaws is an important feature of this machine. The chucking pressure is regulated on each spindle by turning an adjustment screw—readings of this pressure being given by gages which are built in at each station in the direct line of vision of the operator. The circular supplementary view shows how provision has been made for these gages.

Still another example of neatly combined control and instrumentation is that afforded by the self-contained wheel head unit built by the Fitchburg Grinding Machine Corp., illustrated by *Fig.* 5. This unit, which embodies several unique features, has been developed for application to plain grinding machines of various makes and models, to give them increased capabilities. The head has built into it means for giving to the wheel rapid traverse; slow grinding feed; grinding dwell or "spark out"; and rapid return to starting position.

Instrument Makers Sense the Trend

Rate of grinding feed is controlled by a hydraulic metering valve; dwell time is governed by a Telechron clock-controlled time delay switch; and a graduated dial operated by a handwheel can be set to give the required amount of stock removal.

Instrument manufacturers have sensed the trend toward built-in instrumentation of industrial machinery. As a result there is becoming available a rapidly increasing variety of instruments designed especially for this kind of service. Some are of small panel type for flush-mounting and are of rugged construction to withstand the inevitably hard usage which they will receive.

Certain others are of the so-called "plug-in" type, the one depicted in *Fig.* 6 being a recent development by Westinghouse. This particular "plug-in" assembly consists of a socket designed for easy mounting in or on the machine, and an instrument unit which is mounted in or dismounted from this socket simply by pushing it in or pulling it out. Contacts are made between spring jaws in the socket and blades on the back of the instrument. By using a variety of the quick-detachable instrument units, the same socket can be used to obtain readings of voltage, amperage, wattage, kilowatt hours, power factor, etc.

SCANNING THE FIELD FOR IDEAS

HIGH efficiency in air cleaning can be attained electrically by a method which takes advantage of the same power that causes feathers to be attracted by an electrified amber rod. The manner in which practical application is made of this old-time feat of "parlor magic" is shown in *Fig.* 1.

While the apparatus illustrated is a demonstration model, the principle is being applied successfully on a commercial scale with equipment of similar character. The demonstration is being made by Dr. Phillips Thomas of the Westinghouse Research Laboratories. He is blowing cigarette smoke down the intake tube. The infinitesimal particles which give substance to the smoke become charged electrically and are quickly attracted to filter plates, to which they cling through electrostatic force.

The action is so swift that the smoke seems to fade into nothingness in a few inches of travel. It is so complete that efficiency close to 100 per cent is attained. Particles as small as one-fifth of a micron (a micron is one-millionth of a meter) are removed. One of the immediately valuable uses found for this air-cleaning system has been in the relief of bronchial ailments due to minute floating particles.

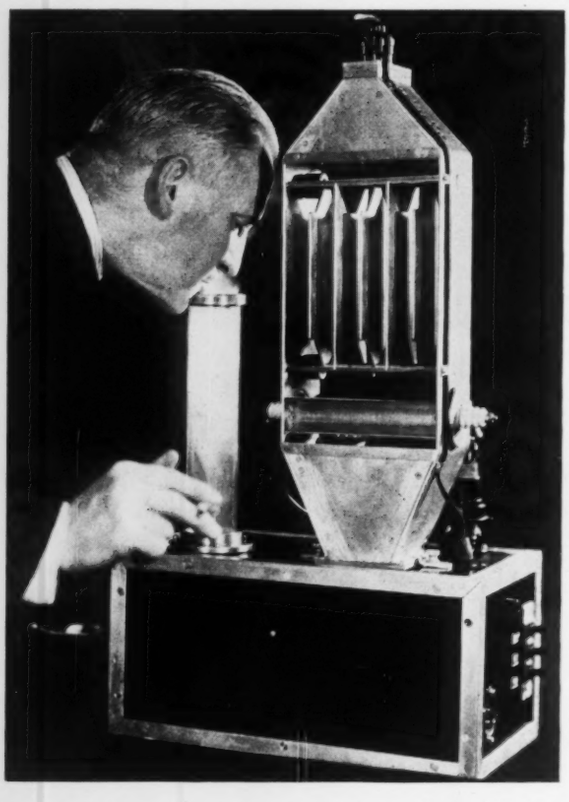


Fig. 1—Cigarette smoke is precipitated electrically in demonstration of air cleaning device

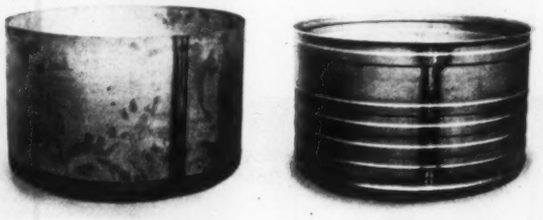


Fig. 2—By welding and rolling, washing machine tubs are manufactured without using expensive dies

Fabricate Tubs by Gas Welding

TYPICAL of improved appearance in design brought about by the use of new materials in construction is the modern household washing machine. So familiar has the sight of the neatly styled enameled metal tub become, that few persons today remember the bulky, ugly and unsanitary wooden washer tub of comparatively a few years ago .

The finished product, with its attractive shape and smooth surface, gives little or no inkling of its method of fabrication. *Fig.* 2 is therefore introduced to show how production engineers of the Horton Mfg. Co. have carried out the ideas of the designers.

To avoid costly dies and a difficult job of deep draw-

ing, a two-piece sheet steel tub has been developed. As is indicated by the view at the left, the wall is rolled up and welded, while the bottom—which is a shallow drawn job of saucer-shape—is in turn welded to the lower edge of the rolled and welded wall.

The interesting point in regard to the welding is that it is by fusion, done by the oxyacetylene process

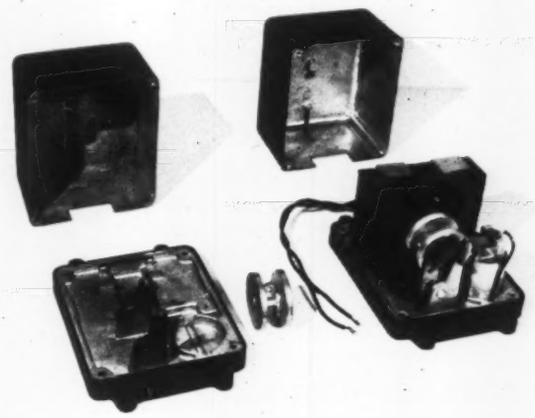


Fig. 3—Die castings simplify assembly of this battery-driven high voltage "flasher"

without the use of welding rods. The edges are brought together under pressure during the welding and the stiffening rings and flanges are rolled on the tub afterward without cracking or tearing the welds.

The view at the right shows the tub following the rolling and flanging operation, but before the application and firing of the porcelain.

Batteries Deliver Shocking Power

DEVELOPED by the National Carbon Co. to make possible the use of 9-volt dry battery units in place of alternating current for energizing neon flasher signals and for giving "shocking power" to electrified fencing, the device shown in *Fig.* 3 embodies several interesting design features.

It is made up of zinc alloy die castings produced by the Hoover Co., and designed to give easy and watertight assembly. The base has cast in all channels for wires and ridges and sockets for assembly purposes. Assembly requires only four self-tapping screws and one set screw, cushioned supports on the transformer causing it to be gripped firmly between base and cover without extra screws or bolts. The cover fits into a trough in the base, their junction being sealed by airplane gasket cement. Wires running out of the unit pass through a rubber block set into a square hole in the rear of the cover, this being compressed to give a watertight seal when the cover is screwed down. Black crackle lacquer gives a weatherproof finish.

The unit develops upward of 5000 volts in the secondary circuit at the momentary makes and breaks of the primary circuit which occur either 80 or 200 times per minute, depending on the service. The interrupting mechanism consists of a solenoid and an oscillating contact mechanism which is a die-cast spool moving on an inclined rack and pinion. The contact point is a ball bearing ball peened into a socket at the center of the die-cast spool. This design detail can be observed in the disassembled spool at the bottom center of the illustration.

With this device a 9-volt dry battery unit will give from two to four months service on traffic flashers, marine signals, railroad crossing warning lights, neon signs, electrified fences and similar apparatus formerly energized only from alternating current lines.

Machine Cover Is Molded Plastic

A GOOD example of the possibilities of molded plastics for machinery parts of considerable size is given by the protective and decorative hood recently developed for use with the standard Western Union teleprinter. This hood, shown in *Fig.* 4, is 14¼ inches wide, 10¼ inches high and 15 inches long. The part itself weighs only seven pounds but the mold in which it is produced weighs five tons and required four months for completion.

While the overall design of the hood was made by Western Union engineers, the General Electric Co., which does the molding, worked out some of the design details to insure a successful job with the phenolic plastic texolite. For instance, as it was not practical to make mold and core from single pieces of steel, it was necessary to design the part so that any unavoidable lines due to junctions between sections of the mold are concealed on the molded parts. Great care had to be taken in heat treating and hardening the mold and core, and in fitting and fastening their component parts to withstand the steam heat and pressure involved in the molding process.

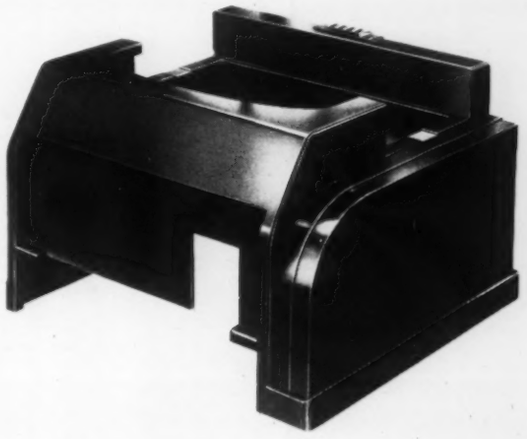


Fig. 4—This lustrous black molded plastic hood requires no secondary finishing

Chrome Plating

By Fred Kelly

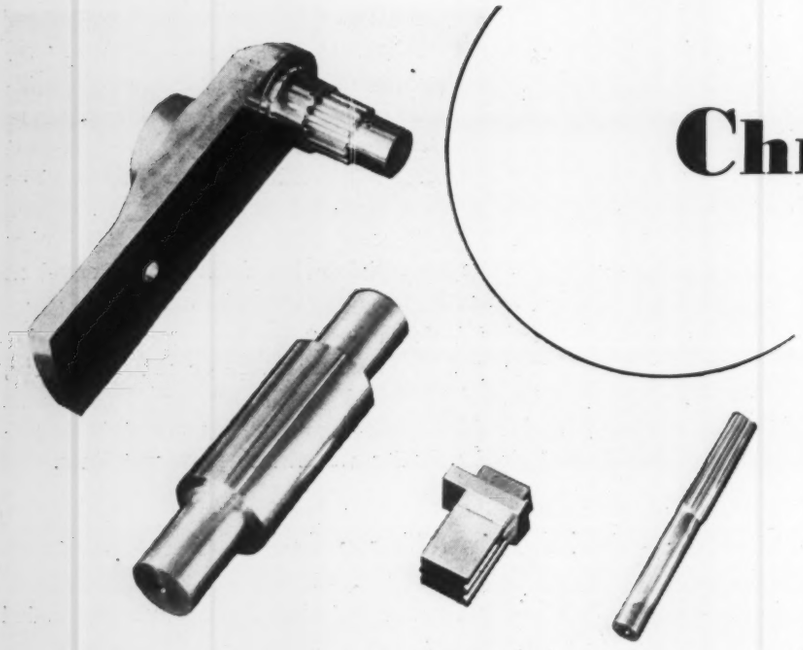


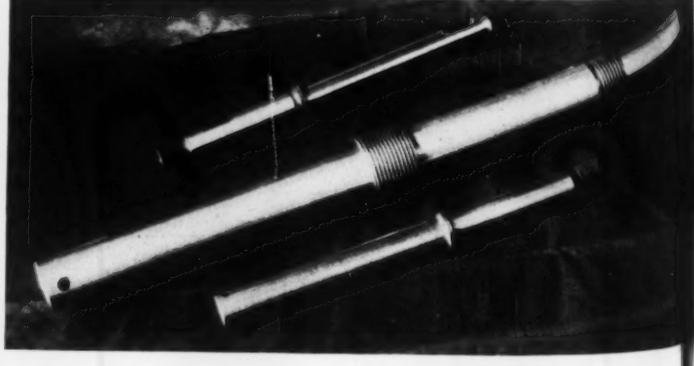
Fig. 1—Chromium plating these parts has given them a wear-resistant surface to prolong life

CHROMIUM began to be used on a comparatively wide scale as an alloy for hardening purposes more than a score of years ago after Elwood Haynes combined it with steel to produce Stellite. Later chromium alloyed with iron and other metals in small proportions produced what is known today as stainless steel. Various investigators began to recognize the value of chromium and by 1926 its use in plating to prevent corrosion and for improved appearance was well established. Strangely enough, chromium was first used as an ingredient in blue pigment and then principally for decorative and corrosion-resistant purposes. Mechanical difficulties in applying heavy deposits, curtailed its use for hardening until recent years; but today it has been proved possible to apply thicknesses up to ⅛ inch.

Consideration of the important properties of chromium shows that it is well suited as a covering for other metals. It is one of the hardest elements in existence. Chromium is rated at 9, as compared with the diamond at 10, in Moh's scale. On the same scale tungsten is 7.5, iron 4.5, cadmium 2 and lead 1.5, This property alone might qualify chromium as an excellent metal coating for wear resistance. Moreover, it has several other attributes almost equally important. Though its melting point of about 2850 degrees Fahr. is not so high as tungsten or platinum, it is higher than iron, nickel, copper, aluminum and the other common metals. Another property which makes chromium particularly adapted for a bearing surface is its low coefficient of friction. The static friction of two pieces of chromium on each other is less than half that of two pieces of steel and about one-fifth that of two pieces of babbitt metal. Because of this low coefficient of friction the life of packings, for instance, around chromium plated pump rams or steam piston rods is increased two to four times.

The linear expansion coefficient of chromium is about the same as glass and platinum, considerably less than the expansion of other metals used for machine surfaces. Non-galling properties provide a surface not easy to score and it will not readily freeze to a bearing. Experience has shown that chromium plate adheres to base metals better than does any other electro-deposited metal. This is an important characteristic because in plating for hardness, chromium is deposited directly on the base metal without a layer of copper or nickel. Any engineer is of course well acquainted with the noncorrosive property of chromium and its wide use as a decorative material.

Fig. 3—Packing wear is decreased and only water is needed for lubrication of these chromium plated pump shafts



ng Combats Wear

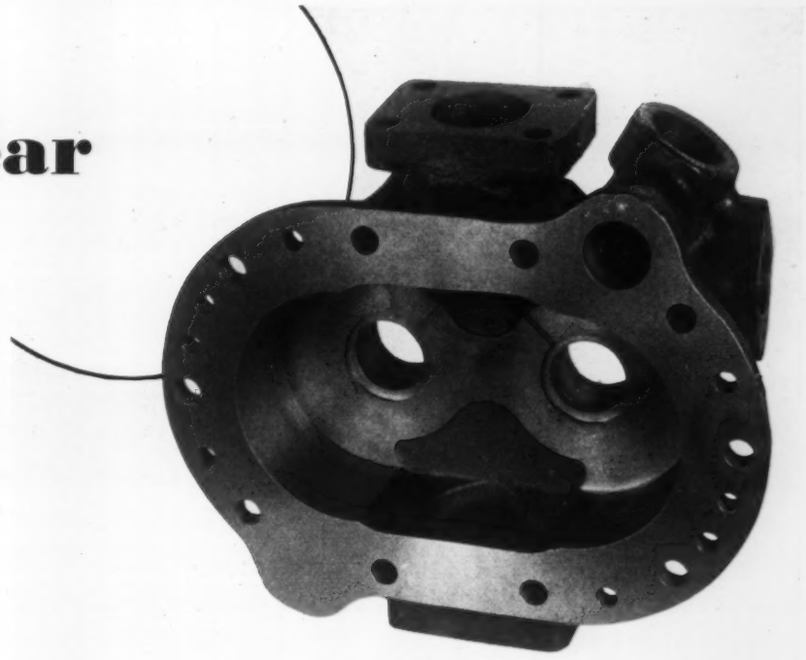


Fig. 2—Close tolerance between pump casing and gears is held indefinitely by plating the inside of casing with chromium

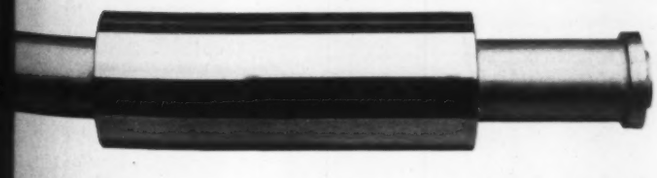
In only one important respect does chromium fall down. Its tensile strength is considerably below that of ordinary metals. For this reason it must depend upon the metal to which it is plated for support and resistance to deformation. The harder and stronger the metal to which it is plated, the better are the results. Brittleness and lack of tensile strength in chromium cause a difficulty for the designer. He must be cautious about specifying heavy plating at sharp corners or edges where the metal would be subject to shock and, therefore, chipping. To avoid this, corners and shoulders of parts to be plated should be designed with a slight radius, though ordinarily these need not be more than 1/64 of an inch.

In chromium plating for hardness the method employed is different from that when only a thin layer is needed for appearance or corrosion resistance. The thin deposits are produced by suspending anodes on each side of a central work rod. When a heavy thickness is to be built up, the chromium is deposited directly on the base metal. To do this and to obtain an accurate and uniform coating, a conforming anode must be used inside or outside the article to be plated. This presents no particular difficulty, except in small holes or at the bottom of deep cavities. In the former, when there is not room to place an anode, plating is out of the question. Where the anode surrounds the part it must be equidistant from it in all directions to obtain an even thickness of chromium. The plating apparatus must be made rigid with sufficiently heavy leads to carry the proper current for hours without heating. Expansion from heat might move the anode slightly. Plating different alloys requires careful study of current densities as well as spacing of the anode and part.

To build up a coating to several hundredths of an inch, a period of five or six hours is required. On cutting tools (not a direct concern of the designer but an example of a chromium application) a thickness of .0001 to .0002 inch can be deposited with little time or trouble. With bearing surfaces, however, requiring a coating varying in thickness from .0005 to .002 inch the process must be continued for a considerable time with exactly the right amount of current.

Experts recommend a high-grade steel, properly hardened, as a base for chromium plate. Any metal plated on a soft base metal may crack if it suffers a blow and the soft underlying metal gives. For certain classes of work, however, it is impossible to use a hardened steel. One example is a part used with electrical equipment which must be non-magnetic and have exceptional resistance to wear. The problem was solved by making the part of bronze, chromium plated.

for lubri



ig. 4—Roll may be used on corrosive materials without damage because of hard chromium surface

Another example is in a process industry where any trace of iron would contaminate the product. Here the part was made of copper, chromium plated to obviate the chance of contamination and also to obtain a diamond-hard surface.

Experience has shown that results are not satisfactory if chromium is plated on over-hardened parts. An article hardened to its maximum will crack on being plated. The obvious remedy is to harden the piece to a slightly less degree.

Applications of chromium plating for hardness are innumerable. For tools and salvaging worn parts, this method has proved invaluable. Designers are now beginning to realize that the hard, corrosion free surface possible with chromium offers many possibilities for original equipment. Any surface encountering purely frictional wear well will be benefitted. The life of many parts has been increased five times. Such parts as journals, ways, feedscrews, spindles, cams and handwheels on machine tools have already been chromium plated. *Fig.* 1 shows several parts and a tool that have been plated with satisfactory results.

Engine Parts Are Plated

The life of pneumatic cylinders has been greatly prolonged by a deposit of chromium. Outboard motor cylinders, crankshafts and pump shafts are logical parts to receive this treatment. *Fig.* 3 is a view of three rotating pump shafts which have been chromium plated. One large company has been plating stems of valves used in diesel engines and found that wear has been much reduced. The stems are also protected from sulphurous fumes from the engine. Another manufacturer of expansion joints for steam lines finds that chromium plating of the frictional surfaces of the joints greatly increases the life of the packing, thus reducing maintenance costs. Reciprocating pump rams plated with chromium give increased plunger life, permit lubrication of the shaft by water alone, give an 80 per cent decrease in packing wear, and because of lower frictional resistance a slight saving in horsepower required to drive the pump.

An interesting application of chromium plating to prevent wear is that of airplane brake drums. Because of the tremendous amount of heat generated in stopping a heavy plane and the limited cooling surface of the drum, pitting and scoring were common. Chromium was plated on the braking surface of the drum and subsequent tests disclosed no tendency to damage the surface. Though it would be possible to heat treat a drum to get a high degree of hardness, it is possible that such a part would warp or crack in the process.

Gear pumps which require a close tolerance between the pump casing and the teeth of the gear for efficient operation have been improved by chromium plating. *Fig.* 2 is an example of the inside of a pump casing showing the portions plated with chromium. *Fig.* 4 is a roll plated with .003-inch thickness of chromium. The main bearing as well as the gaging collets on each end are plated. This extends the life of the roll several times.

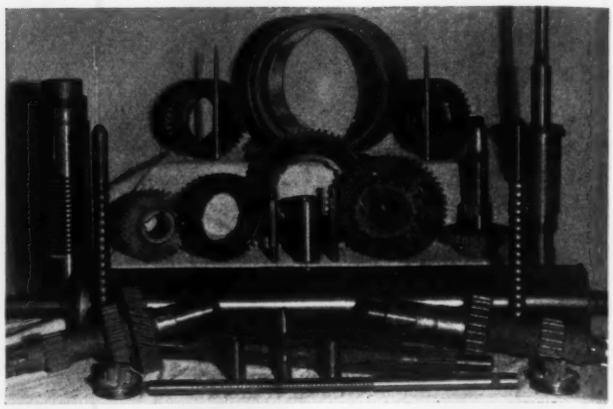


Fig. 5—Typical example of chromium plated machine parts shows wide variety of uses

The printing industry uses chromium to increase the life of many printing surfaces such as steel engraving plates, rotogravure rolls and textile printing rolls. In the field of dies and molds the most outstanding success has been in the molding of plastics. Here, although it is usually not so essential to hold dimensional accuracy, the finish of the molded product is of extreme importance and chromium's easily polished surface provides an ideal molding die. In addition to being hard and smooth, a chromium surface is resistant to any corrosive action of the materials being molded.

In the textile industry one of the greatest problems has been the wear caused by threads passing through spinning, knitting and weaving machines. Steel guides, heavily chromium plated give satisfactory service. Zinc diecast pulleys, over which the thread passes, have been plated with chromium and their life increased. Moreover, with a chromium surface there is no soiling of the thread nor corrosion from a moist atmosphere. *Fig.* 5 shows a number of parts successfully chromium plated.

It would sometimes be a needless expense to plate parts with chromium for the machine would be obsolete before it would wear out. But there are plenty of opportunities. The consumer will gladly pay a premium for a machine that will combat time and corrosion and give trouble-free service. Chromium plating offers the hard surface that engineers have sought and those who aim to build an excellent product will avail themselves of it.

Acknowledgment is made to the following for their considerate assistance in the preparation of this article: United Chromium, Inc.; The Hale Chrome Service, Inc.; The Master Chrome Service, Inc., and Pratt & Whitney Co.

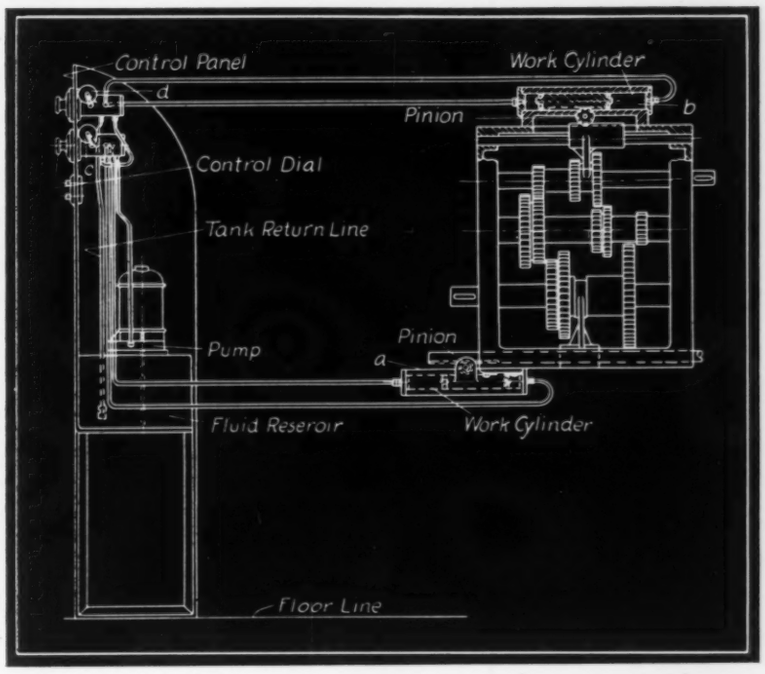


Fig. 1—Nine-speed transmission is remotely controlled by self-contained hydraulic system

Control Is Simplified with Hydraulics

By A. M. Wasbauer

ONE-MAN operation of large machines calls for a precise method of controlling remote elements from a central panel or control station. Distant parts must be moved easily by the operator with a minimum of lost motion. Selecting speeds of a large gearbox requires not only exact control but relatively high effort which cannot be accomplished with ease manually. Chains and sprockets, solenoids and extended levers or arms have all been utilized for actuating remote mechanisms but none possesses the combined advantages of hydraulic control.

Remote elements may be controlled hydraulically though they be separated by corners and other parts of the machine which would interfere with a chain or pulley arrangement. Solenoids are ruled out in cases where extra heavy effort is required and motor-driven units for remote control are sometimes difficult to operate precisely.

The principle of hydraulic operation is subject to many variations but basically the adaptation is the same for all remote control. A simple application of the system is shown in *Fig.* 1. Many machines have speed boxes requiring cumbersome levers and linkages to move the change speed shafts. In this nine-speed transmission, shifting is accomplished by racks, hydraulically driven, geared to the shifter forks through a pinion. In *Fig.* 1 the racks move in cylinders, *a* and *b,* connected by copper tubing to the control cylinders, *c* and *d.*

Fluid power for shifting is obtained from a small motor-driven gear pump operating in an oil reservoir placed within the housing of the control panel, *Fig.* 1. If shifts are frequent the pump may be allowed to run continuously; if infrequent, a pushbutton switch for the pump motor is located near the control dials, or the switch may be arranged to operate automatically with the initial movement of the dials.

A cylindrical rack similar to the cylinder and rack on the gearbox is housed in the control unit shown in *Figs.* 2 and 3 and with the pilot and trailer elements forms the control valve mechanism. The trailer part, *Fig.* 2, is geared to the rack and the pilot element is fastened to the control dial. The system forms a closed circuit which can be maintained under constant, moderate pressure by introducing a resistance valve in the return line to the reservoir. Turning the dial in one direction admits pressure at one end of cylinder *a, Fig.* 1, and the oil, discharged at the other end, enter cylinder *c* to actuate the cylindrical rack and trailer, *Fig.* 2. This action is reversed, of course, by turning the dial in the opposite direction.

Since the work cylinder is actuated by the discharge

from the control cylinder both work and control cylinders should be of equal cubic capacity, but the diameter and length of rack can vary in the two cylinders, depending on the degree of turning movement desired in the control dial.

Referring to *Fig.* 2 it is seen that the trailer element is a cylindrical shell provided with six peripheral channels, 1, 2, 3 and 4 in the pilot. These are shown in detail in the cross section of the pilot and trailer. The channels *A* and *D* are the trailer intake and exhaust channels respectively; *B* and *C* lead to the work cylinder and *E* and *F* to the control cylinder. Channel 2 is the pilot intake, extending from *A* to *C* while 1 is the pilot transfer channel extending from *B* to *F* and 3 is the pilot exhaust channel extending from *D* to *F*.

When the pump is running with the regulating valve at rest, the oil has a free circuit from the pipe line 5, through channel 4, channel *D* and pipe line 6 to the reservoir or the next control unit, depending upon the number of cylinders being operated. In *Fig.* 1 two controls are served by the pump. One line leads to the intake channel of control unit *d*, and then through the outlet line to the reservoir. Thus a single circuit may serve any number of controls. Since all cylinder communication is closed with the valve at rest, the racks are held in position by the oil trapped in the cylinder. Means of occasionally venting the air that collects in any system such as this are too well known to require description here.

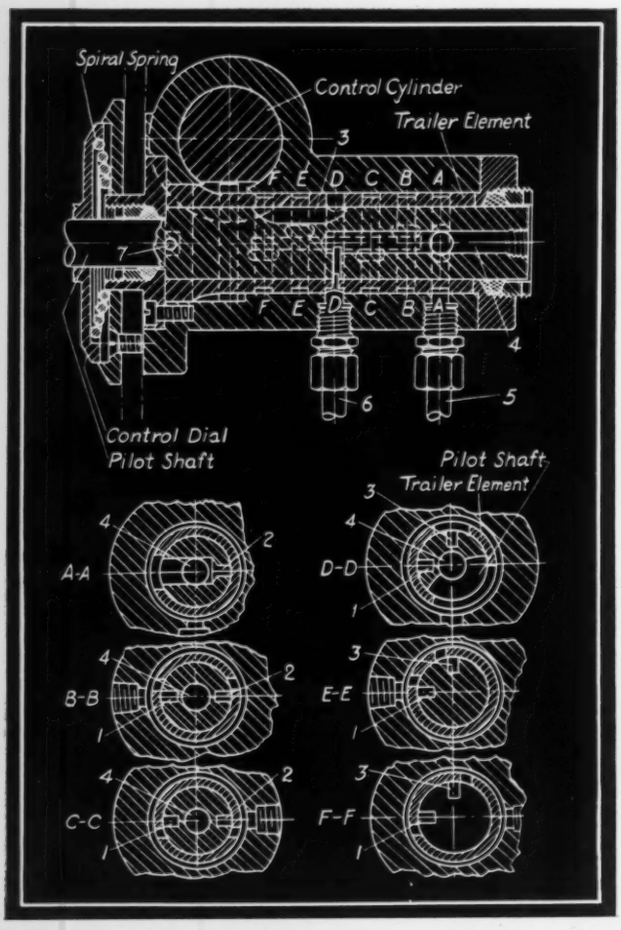


Fig. 2—Inlet and outlet valve system permits work cylinders to be operated by slight twist of control dial

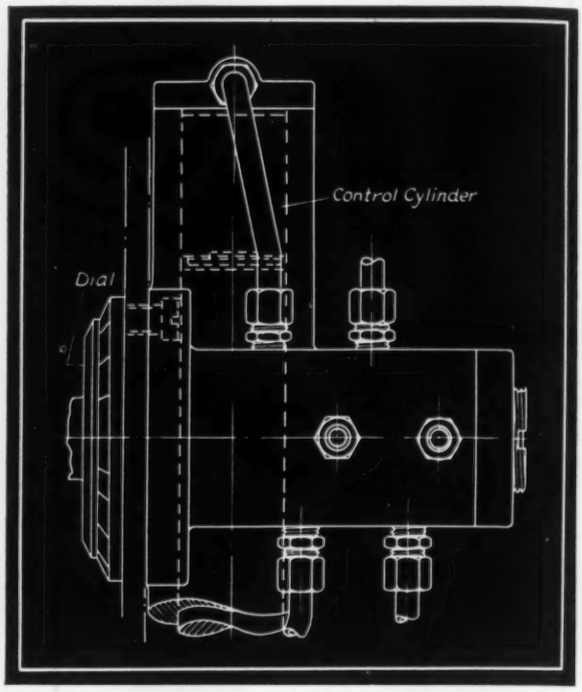


Fig. 3—Control cylinder and valves are integrally built in single housing

The spiral spring in *Fig.* 2 normally keeps the pilot in the axial position to give the oil a free circuit. To operate, it is necessary first to displace the pilot axially until its slot no longer registers with the trailer slot in channel *D*, which will block the circuit. Then as the dial is rotated, the response of the trailer in following the pilot will be almost instantaneous. Since the least turning movement of the pilot admits pressure to the work cylinder, and any movement of the gearbox rack entails a corresponding movement of the control rack, it follows that the relative angular position of the pilot and trailer must be maintained except for the lead of the pilot in cracking the ports. The amount of lead of pilot over trailer will, of course, depend on the speed of dial manipulation and on the relative cubic capacity of pump and cylinder. It is assumed that an adjustable relief valve is built in the pump. The pin, 7, projects from the pilot through a slot in the trailer element to limit the relative movement of these two components.

With proper leather cups at each end of the work and control cylinders, no trouble should be experienced from leakage within the cylinder. However, should the synchronism of the racks be disturbed by any cause, it can easily be restored at one end of the strike by allowing the laggard side to creep up under pressure. Where a momentary obstruction is encountered as happens in shifting gears with solid tooth clutches, the dial is rocked back and forth until engagement occurs, just as would be done in shifting with crank or lever.

Exhibition Discloses Progress in Foundry Machines

DESPITE their basic importance to the machinery building industry many foundries continued to be relatively unmechanized far on into the present "age of machinery." Granted that skill of hand necessarily played—and still plays—an important part in foundry technique, it nevertheless is a fact that successful mechanical devices have long been available which have been designed to relieve foundry workers of a large part of the purely physical labor in which only a small degree of skill is involved. Today, we should add, wide use is being made of this mechanical equipment. As a result, foundries generally are much better places in which to work than was the case only a few years ago. At the same time production efficiency has risen to a marked degree, better castings are being turned out, and safety has been increased.

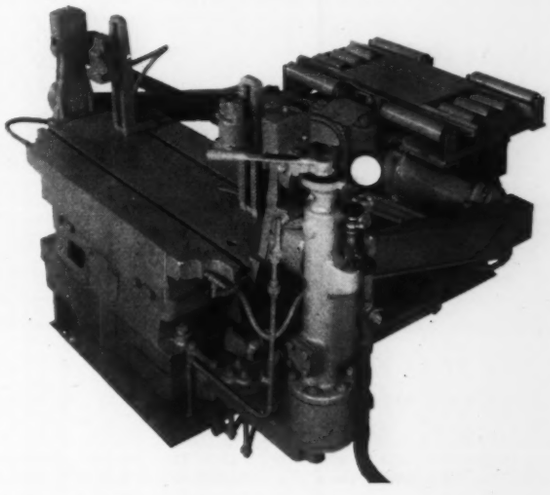
To any mechanical engineer or machine designer, even though his primary interest in foundry practice is only aroused through his being a specifier of castings, a visit to the recent Foundry Show in Milwaukee was an exceedingly interesting experience. Among outstanding impressions gained by such a "non-foundry" observer were: First, the extent to which compressed air and hydraulic means have been adapted to the energizing and control of foundry machinery; second, the extent to which mechanical materials handling methods are now utilized in the foundry; and third, the constructive attention now being paid to prevention and elimination of dust and smoke in foundries.

Air and Hydraulic Actuation

Typical of compressed air and hydraulic applications are those embodied in molding machines—particularly those of semiautomatic jarr, roll-over and pattern drawing type. With the operator manipulating a single valve located at the strategic position, the mold is first jarred on a pneumatically vibrated plate, the flask being firmly held by air clamps which operate instantly. When proper sand density has been attained, jarring automatically ceases and the rollover mechanism, which usually is hydraulic, comes into action. Flask and pattern together are raised smoothly from the vibrator, turned over and deposited in position for drawing the pattern. This last delicate operation is accomplished with speed and precision by drawing flask and mold away from the pattern on a hydraulic ram. At the lower limit of travel of this ram the flask is deposited upon a roller table, from which it is readily transferred into the production line.

Equipment for sand conditioning and handling represents a tremendous advance beyond the wheelbarrows, scoop shovels and hand riddles of yesterday. Sand cutters which remind one of power driven agricultural machines, riddles vibrated by compressed air or by electrical means, and mixer units embodying shakeout hopper, magnetic separator, muller, aerator, skip loader and dust removal system are among the developments in this field.

Dust is guarded against in two ways, first by not creating it; and second, by removing it and precipitating it when it is unavoidable. Dust-tight tumbling barrels and cascade mills, properly enclosed and hooded sand blast equipment and airless sand blast systems hold down the creation of dust; while generous use of air ducts coupled with separators of cyclonic, water spray dynamic, screen or electrical type, together with washed air supply systems, eliminate dust if it is created.



This roll-over machine is typical of many new units designed to utilize compressed air and hydraulics

Future progress development of foundry equipment probably will be along the lines of "cleaning up the designs," including the building in of piping, driving and control mechanism; and in the elimination of undue noise in operation. There still remains some room for improvement in those directions, judging by standards set by industrial machinery in general.

Necessary

Rubber

By C. F. Hirshfeld
and
E. H. Piron

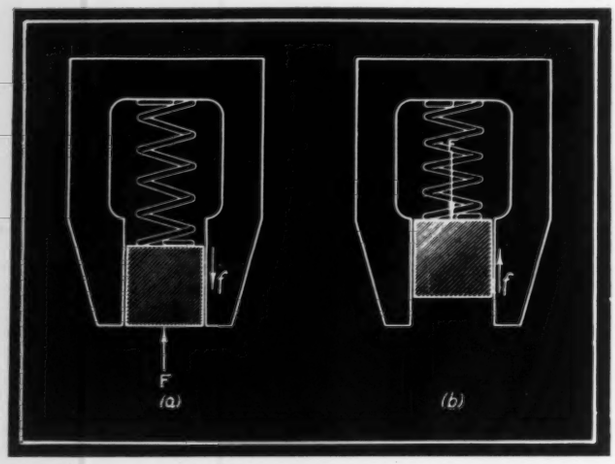


Fig. 1—If rubber springs were used in this installation friction from guides would be eliminated

AS RUBBER has come into use as a springing material and has begun to displace steel and other metals for such purposes there has developed a regrettable controversy between the suppliers and the advocates of the two materials. This is regrettable because the arguments presented frequently have been partisan and therefore have tended to obscure the real facts and to delay impartial analysis. A case can be made for either material by properly choosing the assumed conditions and thus concentrating attention on this or that property or combination of properties.

It may be said categorically that rubber cannot completely displace metal as a springing material. But it is equally true that for certain conditions rubber is far superior to any known metal for springing purposes. The task of the engineer is the determination of the conditions under which rubber gives the better solution and the accumulation of the technical knowledge required to enable him to make the best use of rubber for conditions to which it is better adapted.

A rubber spring that carries a heavy load would probably cost more than the dynamically equivalent steel spring. Therefore the engineer must find in rubber springs desirable characteristics not yet mentioned if he is to apply them in place of metal springs. There are such characteristics, and the authors—in common with many others—believe that some or all of these are sufficiently weighty in connection with certain applications to justify the use of rubber springs in such cases. A few of these considerations are explained below.

(1) It is common practice to use guides of some sort when parts are separated by metallic helical springs used in compression. This introduces frictional forces which are always so directed as to oppose the intended action of the spring. This is shown diagrammatically in *Fig.* 1, *a* and *b*.

Such considerations are not of great consequence in the case of well lubricated machinery. They may become serious however in other cases. An example is furnished by the common journal box springing of many rail vehicles. Here exact fits are not ordinarily obtained or maintained and lubrication is bound to be more or less imperfect. Moreover, as wear occurs and clearances develop, there results not only a less perfect guiding of parts but also the production of objectionable noise.

(2) Metals transmit audible vibrations, that is sound, much more readily than does rubber. When used for springing purposes metals ordinarily are arranged so as to provide a complete metallic path between the place at which noise is generated and large metallic or other surfaces which serve as excellent broadcasting media. Attempts have been made to decrease the volume of sound transmitted in this way by using rubber cushions or other equivalent devices in the path. This has not been uniformly successful because the tendency is to use sound insulating cushions which can be fitted into existing dimen-

SUPPLEMENTING "Rubber Affords Protection for Machine Parts" which appeared in last month's Machine Design, the editors present this abstract from a paper given at the semiannual meeting of the A.S.M.E. which describes other uses and properties of rubber. Mr. Hirshfeld is chief of research, The Detroit Edison Co., and Mr. Piron is associated with the Transit Research Corp.

Qualities Found in Springs

sions. The unit loads to be supported by the rubber cushions under such conditions frequently are so great that the cushion material cannot be given those physical characteristics necessary for maximum sound absorption.

(3) Multiple leaf springs possess inherent frictional losses which perform a useful function as damping devices but nevertheless give such springs certain undesirable characteristics, particularly for vehicle springing. Two types of friction in these springs must be recognized, friction of rest and friction of motion. Both act to oppose the action of the spring somewhat as illustrated in *Fig.* 1 already referred to.

Since rubber suffers relatively large deformations when acted on in tension, compression, or shear, it is possible to use it as a spring with any one of several methods of loading. However, each method has certain individual characteristics which fit it best for certain types of springing. It is therefore appropriate to consider these characteristics.

Rubber in tension has tremendous abilities as an accumulator of potential energy and is capable of astoundingly great extensions. This naturally fits it for use as a springing material in tension. However, it has several undesirable characteristics when used in this way. These have limited the rubber tension spring to special applications.

Most important is the great sensitivity of stretched

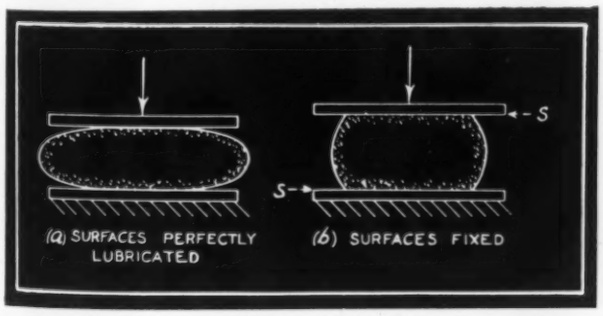


Fig. 2—Fixed rubber surfaces as shown at the right offer more resistance than those which can slide as on the left

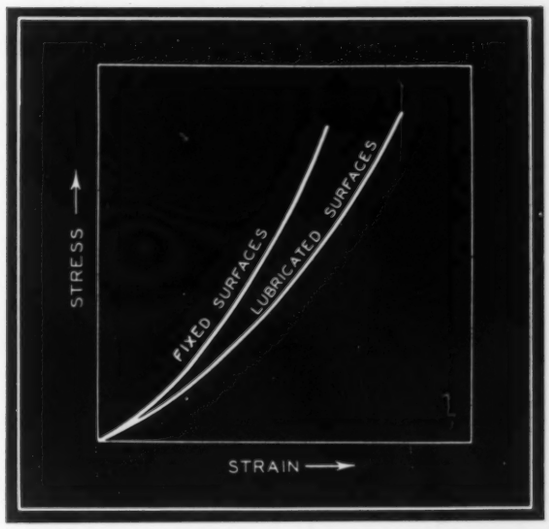


Fig. 3—Stress-strain graph for rubber neither lubricated nor fixed would lie about midway between these two curves

rubber to physical injury. It is comparatively difficult to cut unstrained rubber. When strained in tension it is cut easily and a cut once made on the surface of strained material has a marked tendency toward auto-propagation so that complete failure is apt to occur.

Again, rubber appears to drift to a much greater extent in tension than under comparable loads of other types and to have a greater elastic lag upon recovery. These characteristics can be explained as following directly from the shape of the rubber molecule and its behavior when loaded in different ways.

It is not easy to provide a means of holding rubber so that it can be used as a tension spring. The simplest method is to use a loop or collection of loops as in the case of the conventional rubber band. This was done in the early airplane landing gears. It would, of course, be possible to mold a dumb-bell shaped piece and to insert the enlarged ends in receptacles of the proper size.

In a general way it may be said that the use of rubber in tension for springing purposes should be confined to those cases in which the stretched rubber can be protected against surface injury and in which the spring is unloaded most of the time. The latter restriction appears to remove this form of spring from the field of vehicle springing and other cases in which a load must be sustained continuously by the spring and plus and minus variations of load accommodated. As a result of the limitations of the tensile type of rubber spring, it has become customary to do prac-

tically all rubber springing with the material in compression or in shear, or in some sort of combination of these two types of loading.

There are two extreme possibilities in compression loading. These are illustrated in *Fig.* 2, *a* and *b*. In *Fig.* 2 *a* the surfaces of the rubber in contact with the compressing faces are assumed to be perfectly lubricated so that they can slide along the compressing faces with negligible friction. In *Fig.* 2 *b* the surfaces are supposed to be relatively fixed so that no sliding can occur.

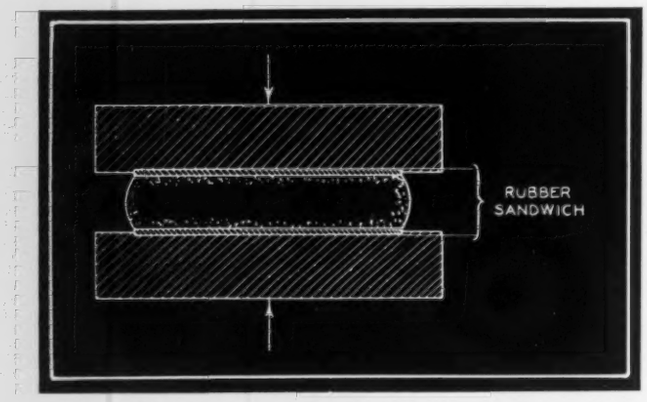


Fig. 4—Rubber is bonded to thin metal pieces which fit between springing surfaces for "sandwich" effect

In the first case, the rubber acts as though it were less stiff than in the second case. That is, a given load produces a greater deformation. The stress-strain graphs would have the relationships indicated in *Fig.* 3, although there is no absolute significance in the relative values shown in the illustration.

Lubricated Surfaces Not Feasible

Under laboratory conditions the perfectly lubricated requirement can be approximated, as for example, by using a soap solution as a lubricant. Under conditions of practical use this is not possible and it is not feasible to use rubber with perfectly lubricated surfaces for springing purposes. It is, of course, possible to compress rubber between two metal surfaces without lubrication. This gives in effect a condition between those indicated in *Fig.* 2. The rubber slips to a certain extent upon the metal surfaces, particularly near the outer free surface of the rubber. The resultant stress-strain graph would lie between those shown in *Fig.* 3 and would approach one or the other more closely as dictated by the amount of relative slip.

Rubber is used for springing purposes to a great extent in just this way. A rubber slab of the required dimensions is merely fitted between two metal surfaces. With the normal grades of rubber and normal loadings the results are almost the same as though the rubber were actually fixed to the metal and did not slip with respect to it. That is, the graph would be almost coincident with that for fixed surfaces in *Fig.* 3.

There are, however, certain precautions to be observed when rubber is used in this manner. Under increasing load there is a tendency for rounding of the edges which contact the metal in the unloaded condition. If there are forces acting in the directions s-s, *Fig.* 2 *b* (assuming the surfaces to be imperfectly lubricated rather than definitely fixed) this causes a shearing effect and there will be a sort of rolling action of the rubber near the rounded edges as the upper and lower surfaces undergo relative displacement. This tends to produce local deterioration of the rubber if it occurs to an excessive degree. The deterioration is probably due to a combination of abrasion and heating.

Rubber Is Bonded

There is a growing tendency to produce a self-contained compression spring in which such action is prevented. This is commonly done by what is known as "curing" or "bonding" the rubber to the metal faces between which it is compressed. But it seldom happens that the metal parts between which a compression spring is to be located are so shaped and of such size that it is convenient to cure the rubber directly to them, and for this reason there has been developed a structure known as a rubber sandwich. The rubber is cured between two comparatively thin pieces of metal and the design of the structure is arranged to receive the sandwich as a springing element. This is illustrated in *Fig.* 4 in which the sandwich is shown in place in a structure and under load as indicated by the bulge in the rubber.

The explanation of the radically different stress-strain performance of the same rubber tested in compression with perfect slip and no slip respectively between the rubber and load-imposing surfaces is comparatively simple. It has been stated that rubber behaves like a liquid, and, for practical purposes, is incompressible. Therefore, when loaded in compression it can yield in the direction of the compressive forces only as it can expand in other directions. Study of *Fig.* 2, *a* and *b,* will indicate the significance of this. In the former the rubber is more free to expand laterally than in the latter. It is therefore capable of assuming a greater deformation in the direction of the compressive forces.

Bulge Area and Deflection Related

It is convenient to remember that for a given grade of rubber used in compression, the deflection for a given load increases as the area ratio decreases. In other words, the deflection increases as the relative bulge area increases. With the horizontal dimensions of the slab remaining constant, this can be accomplished by increasing the height. With the height

remaining constant it can be accomplished by using a more elongated slab or a perforated slab when dealing with rectangular cross-sections. With short, cylindrical slabs and constant height it can be accomplished by decreasing the diameter.

In the case of sandwiches used in shear it has been quite common to limit the unit static shear stress to 20 pounds per square inch and most designers now prefer not to exceed 40 pounds per square inch. Shear sandwiches have been proportioned on both these values to carry the same loads and at the same deflections as the compression sandwiches just referred to.

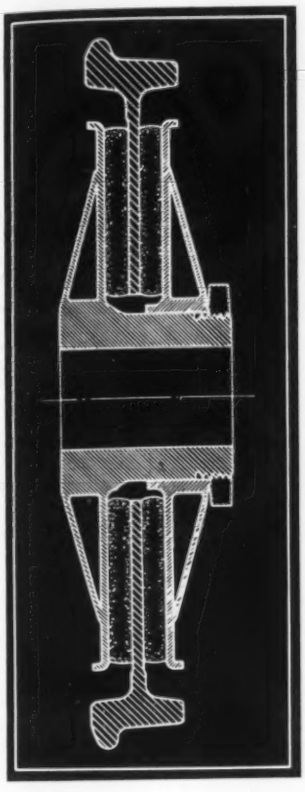


Fig. 5—Wheel of street car is entirely separated by rubber from hub in this design

The choice between compression and shear loading cannot be placed on any universally advantageous characteristic of one or the other type. The decision must be made as the best compromise in each case. Such things as available dimensions, directions in which the forces are to operate, freedom desired in directions other than that of the principal force considered and others may all come in for study.

For example, a compression sandwich is capable of functioning as a shear sandwich in all directions at right angles to the line of compressive force. It will function as a shear sandwich if there are forces at an angle to the line of the compression force and if the structure into which it is built permits. Again, a simple shear sandwich is capable of acting as such in two directions at right angles to each other and as a compression sandwich in a direction at right angles to both of these.

As another example, it may be convenient to suspend a heavy machine or engine by means of shear sandwiches fastened along the sides of the frame or underframe, and most inconvenient to place compression sandwiches under the structure.

With the assistance of others, including research men, street car operators, street car manufacturers and rubber manufacturers, the authors have developed during the past few years a street car in which rubber is used for several different springing purposes. One objective was the reduction of the unsprung weight. Another was the reduction of noise made by the street car. It was felt that the first objective could be reached by the use of a resilient wheel, and that the second could be furthered by using rubber as the resilient material. After the trial of many semi-commercial designs and the development and trial of many designs of our own, the one shown semi-diagrammatically in *Fig.* 5 was adopted. It is now in use on several hundred cars and appears to be reasonably satisfactory. The earliest models have now operated about 70,000 miles in commercial use.

Steel Tire Clamped in Rubber

Inspection of *Fig.* 5 will show that the web of a conventional steel tire is clamped between two rubber sandwiches by two cheek plates connected to the hub of the wheel. The tire can thus move radially by deforming the rubber in shear and axially by deforming the rubber in compression. The rubber is so proportioned in the later wheels as to permit a radial deflection of about 3/16-inch under a radial load of 8000 pounds. Under the conditions of use with the maximum passenger load, the static load is less than 7000 pounds.

The noise produced by transmission of vibrations directly from the tire to the air still remains. Much effort has been expended in attempts to devise a tire construction which would transmit less in this way. A number have been found which were satisfactory from the noise standpoint but, unfortunately, none of them had sufficient strength to give the necessary life in service.

Noise Reduced by Tire Mounting

The completely unsprung weight is reduced to that of the tire, its web and the adjacent sandwich plates. Reduction of noise level is also achieved because the noise generated at the wheel-rail contact cannot be transmitted metallically to the hub and axle and from them by metallic paths to the remainder of the truck and the car body. Such noise energy as passes into the web must pass through the rubber sandwiches to find its way into the remainder of the structure.

The springs upon which the car body is carried are of a novel form shown in *Fig.* 6. They consist of four "cylinders" of rubber bonded to flanged metal cylinders as shown in the cross-section. The rubber in each section has a thickness of about one inch. The height of rubber diminishes from the center toward the outside so as to approach constant shear area. This is not carried to the limit that is possible because the spring will then have inadequately lateral stability for the purpose intended. That is, if the bottom were

held, the top could be moved sidewise too easily.

As constructed, the central section forms the weakest spring. The load-deflection ratio increases in successive sections as one moves outward. The umbrella structure moves downward as the spring picks up load and it puts out of action one after another of the cylinders. The static load placed upon the spring with empty car is of the order of 1600 pounds. The static load with maximum passenger load is of the order of 2900 pounds. It will be observed that the part of the graph applying to light load conditions would give a negative intercept on the deflection axis if continued backward as a straight line. This makes the spring softer for such conditions. As the load increases from one limit to the other there is a step by step stiffening of the spring which tends to proportion it to the load in such a way as to approach a constant frequency. At the upper end the spring becomes very stiff so as to snub violent impacts.

The spring was designed to give comparatively large deflections in the vertical direction and small but measurable ones in all horizontal directions. It will be observed that the form is ideal for such purposes.

The experience that the authors have had in adapting rubber to the springing of street cars and to other mechanical engineering purposes leads them to believe that there is a tremendous and hardly touched field for the use of rubber for mechanical purposes. It is a material with many unique characteristics which the mechanical engineer can use to good advantage in many applications if and when the necessary technical information becomes available.

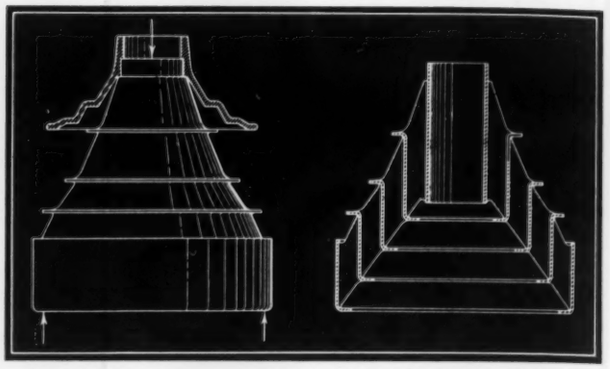
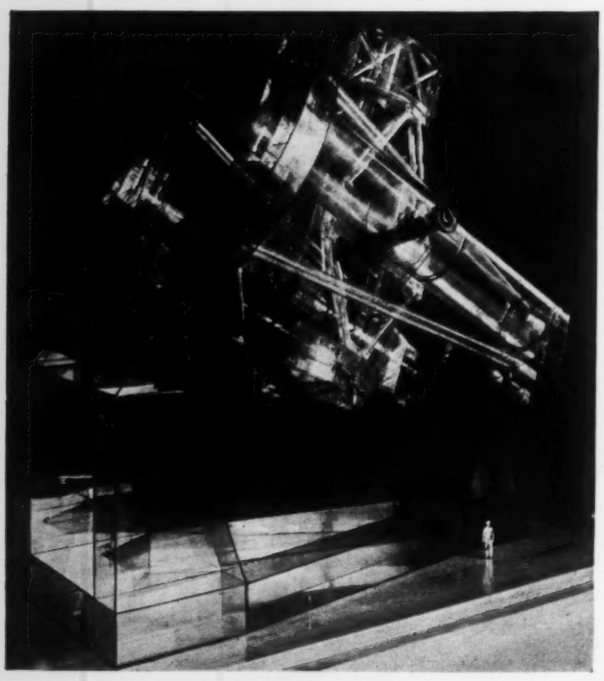


Fig. 6—Body of street car is carried on rubber springs which permit great vertical deflection

Plastic Model Facilitates Telescope Design

BEFORE the gigantic 200-inch telescope being made by Westinghouse Electric & Mfg. Co. ever took shape, engineers constructing the structure had checked theoretical calculations on a small plastic model. Although the use of models in engineering construction dates far back, a scale model made of translucent plastic is something unique. Total cost of the model was $2000.



Built to a scale of 1/32, the model enabled engineers to visualize the structure not only from its outward appearance but, because of the translucency of the material, in section views. Pyroxylin was the plastic used. Sheets were cut to shape and then firmly cemented with acetone. As the acetone dissolves pyroxylin, the union is as solid as a welded joint. The acetone dries and sets in a few seconds.

About six months was spent in preliminary tests on the miniature telescope. Angular deflection tests under load were carried out with the yoke in every position. Several desirable changes were made in the design of the 200-inch telescope from observation of the model.

To prevent squeezing or marring of the model, micrometers used in measurements were tied into an electrical circuit. When contact is made with the surface, meters give the reading.

The model as well as the telescope was designed originally by members of the staff of the California Institute of Technology.

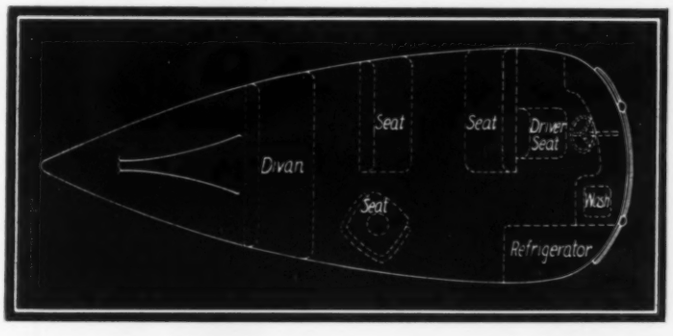
Aircar Points to Auto of Future

TRAILER devotees and motorists partial to the rear-engine auto will be interested in the design of a streamlined vehicle now undergoing tests which combines living quarters and power plant.

Radical in its appearance as well as mechanical features, the "Pribil Safety Air Car", made by the Saginaw Stamping & Tool Co., incorporates individually sprung wheels, seats convertible into sleeping couches, integral body and frame construction and a washstand and refrigerator.

Special emphasis has been placed on safety in the design of the car. The driver sits within a few inches of the front where he has unobstructed vision in all directions. Steel is used for all parts of the integral body and frame. Light structural shapes form the squirrel cage of the frame, insuring rigidity and strength. The walls of the body are insulated against heat, dust and sound by a special mica compound and the windows are sealed against dirt.

Mounted on the flywheel of the engine is a sheave, connected by several V-belts to the transmission situated directly under the engine. The clutch is built-in to the transmission sheave. Drive is through the rear wheels which are placed 14 inches apart. This design insures stability yet allows a body taper in conformance with streamline practice.



Unusually easy riding characteristics are achieved through the independently sprung wheels, each suspended on a variable pitch coil spring with built-in shock absorber. The 30-horsepower engine will drive the auto completed loaded at 50 miles per hour with considerable more fuel economy than an auto and trailer combination.

Trim in appearance, serving the double purpose of living quarters and transportation, the aircar or similar machines may play an important part in the design of the automobile of the future. Car manufacturers have found a public wary of radical change, but perhaps the combining of trailer and auto will prove the wedge to gain its approval. In any event is should prove popular with persons who enjoy camping in their autos, for it is easily changed into a livable compartment.

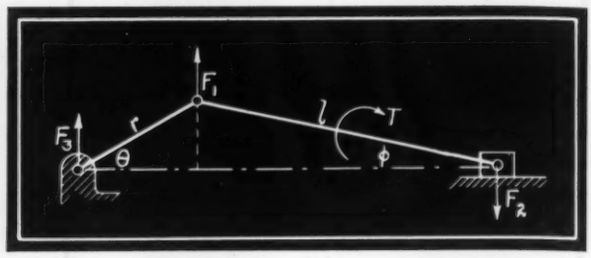


Fig. 1—Inertia effects may be calculated with the crank in any position

Inertia Forces Must Be Known for Engine Balance

By George L. Guillet
Assoc. Prof. of Mechanical Engineering
Pennsylvania State College

TO DETERMINE the effect on engine balance of inertia forces it is necessary that all forces and couples produced by moving parts be taken into consideration. Moving parts of the conventional engine fall into three groups: First, parts which reciprocate along the line of stroke, including the piston assembly and the piston rod and crosshead where such are in use; the second group comprises rotating parts, generally the crankpin and crank webs, and the third group is made up of the connecting rod assembly, the motion of which is that of reciprocation at the wristpin and rotation at the crankpin end. Intermediate points move in paths which somewhat resemble ellipses but which are not, however, truly elliptical.

Considering for a moment a single-cylinder engine and assuming that the crankshaft rotates at a uniform rate, the inertia effects of the first two groups may be summarized as follows: Reciprocating masses, because of their linear acceleration and retardation set up variable forces acting along the line of stroke. The connecting mechanism causes these forces to produce turning couples on the crank which alternately act to assist and retard rotation. A reaction couple equal and opposite to that acting on the crank at any instant is transmitted to the engine frame.

Rotating masses move in circles with constant velocity and therefore set up centrifugal forces, which at any instant act outward along a line from the center of rotation to the center of gravity of these masses (usually along the center line of the crank). The complexity of the connecting rod motion makes the determination of the inertia effects caused by it, a matter of laborious calculation if we attempt a rigid mathematical analysis. However, a simple approximate method is recommended by the texts on the subject and is often used.

This method assumes that the connecting rod is

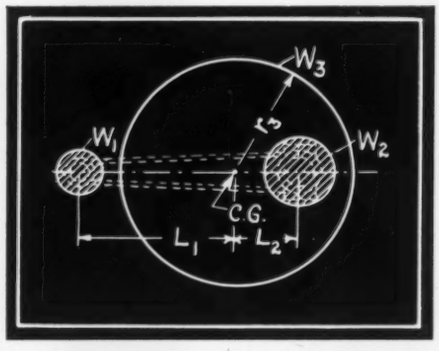


Fig. 2—Formulas are derived from this system of masses which produce same inertia effects as actual rod

dynamically equivalent to a system consisting of two weights, one reciprocating with the wristpin and the other rotating with the crankpin. If the rod is supported horizontally on knife edges placed at the axis of each bearing, these weights will be equal to the reactions at the knife edges. The same result may be obtained more easily by balancing the rod across a single knife edge and thus finding the location of its center of gravity. The weights to be considered as reciprocating and rotating, W_1 and W_2 respectively, may then be computed since $W_1 + W_2 =$ the total weight of rod and $W_1L_1 = W_2L_2$ where L_1 and L_2 are the distances from the center of gravity to the axes of the wristpins and crankpins. However, in order to reproduce the inertia effects of the actual rod exactly, a substituted system of masses must comply with the following requirements:

(a) The sum of the substituted weights must equal the weight of the rod

(b) The center of gravity of the system of substituted weights must lie at the center of gravity of the rod

(c) The moment of inertia of the substituted weights about their center of gravity must be the same as that of the rod

A system comprising the weights W_1 and W_2 as de-

termined above evidently fulfills the first two requirements, but not necessarily the third, for when dealing with a rod of usual proportions the moment of inertia is less than that of the weights W_1 and W_2 concentrated at the pin centers. Herein lies the error in this method. Of course, it is quite possible to design a rod which eliminates this error, but it would require unusual weight at the extreme ends.

Does the approximate method give results of reasonable accuracy or is a more exact but more complicated method desirable? What is the nature of the error in the approximate method? The writer will endeavor to answer these questions by applying both methods to an automobile engine.

A system of masses is shown in *Fig.* 2 which satisfies the three requirements listed in the foregoing* and which therefore will produce the same inertia effects as the actual rod. Referring to *Fig.* 2, we have weights W_1 and W_2 concentrated at wrist and crankpins respectively, of the same values as used for the approximate method and a ring attached to the connecting rod of large radius r_3 but light weight W_3. The values for W_3 and r_3 are such that the moment of inertia of the ring, $W_3 r_3^2$, is numerically equal to the difference between the moments of inertia of the original rod and that of the weights W_1 and W_2. That is

$$W_3 \ r_3^2 = I_c = I_a - I_b \quad \ldots\ldots (1)$$

where I_c = moment of inertia of the ring
I_a = moment of inertia of the rod about its center of gravity
I_b = moment of inertia of the two weights W_1 and W_2 about the center of gravity of the rod, which equals

$$W_1 L_1^2 + W_2 L_2^2 \ (see\ Fig.\ 2) \quad \ldots\ldots (2)$$

Regarding the ring, W_3 is assumed to be so small that its linear displacement requires negligible force, and r_3 is made correspondingly large in order to give the required moment of inertia.

The quantity I_a can be found for any rod either by calculation or by the suspension method. The latter method is always much easier and is carried out by hanging the rod on a knife edge passing through either of the pin holes. We thus produce a pendulum whose time of swing is a direct measure of the moment of inertia of the rod about the axis of suspension. By the usual handbook formula applying to the pendulum, we have

$$I = \frac{W l_o g t^2}{\pi^2} \quad \ldots\ldots (3)$$

where I = moment of inertia about the suspension axis in footpound units
W = connecting rod weight in pounds
g = 32.2
t = time of a single swing to right or left in seconds
l_o = distance from the axis of suspension to the gravity axis of the rod

Since it is desired to find the moment of inertia of the rod about its own center of gravity, a transfer of axes must be made and

$$I_a = I - W l_o^2 \quad \ldots\ldots (4)$$

Having found I_a and I_b the difference (usually negative) equals I_c in accordance with (1).

It is now clear that the error caused by the use of the approximate method is equal to the disturbance set up by angular acceleration of a ring with its moment of inertia equal to I_c attached to the rod. The next step is to ascertain the nature and magnitude of this disturbance and by comparison with the forces and couples calculated by the approximate method determine the percentage of error in using this method.

At any position of the mechanism as shown in *Fig.* 1 the crank angle being θ and the connecting rod angle ϕ, (by taking the first and second differential with respect to time) the angular velocity of the rod is $d\phi/dt$ and its angular acceleration is $d_2\phi/dt^2$. Hence the couple caused by the angular acceleration of the attached ring is

$$T = \frac{I_c}{g}\left(\frac{d_2\phi}{dt^2}\right) \quad \ldots\ldots (5)$$

The action of this couple results in forces F_1, F_2 and F_3 acting along vertical lines as shown in *Fig.* 1. These forces are all of equal numerical value, and

$$T = F_1 \ l \cos\phi \text{ or } F_1 = \frac{T}{l \cos\phi} \quad \ldots\ldots (6)$$

The force F_1 produces a crankshaft couple of value $F_1 \ r \cos\theta$. Substituting the value of F_1 from (6) the

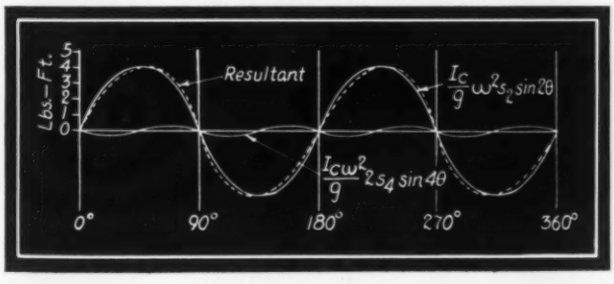
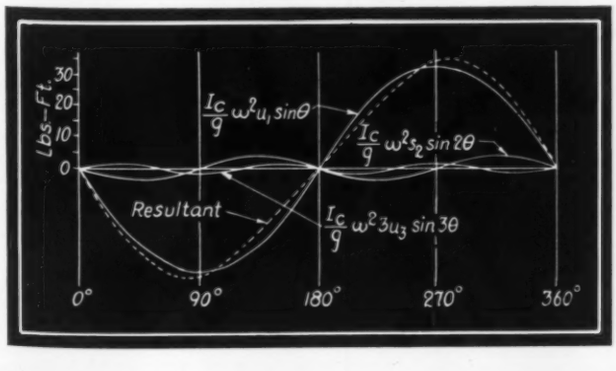


Fig. 3—Resultant of the crankshaft torque correction is figured from the two important crank harmonics

Fig. 4—Torque correction for the engine frame includes three different harmonics



*A method suggested by Cormac in his book "Balancing of Engines."

crankshaft couple equals

$$\frac{T\,r\cos\Theta}{l\cos\phi} = -\frac{I_c\,d_2\,\phi\,r\cos\Theta}{g\,dt^2\,l\cos\phi} \quad \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

The minus sign indicates that the couple acts in a sense opposite to that of T. But from *Fig.* 1, $r \sin\theta = l \sin\phi$.

Therefore, by differentiation

$$r\cos\Theta\,\frac{d\Theta}{dt} = l\cos\phi\,\frac{d\Theta}{dt}$$

and hence

$$\frac{r\cos\Theta}{l\cos\phi} = \frac{d\phi}{dt} \div \frac{d\Theta}{dt} = \frac{Angular\ Velocity\ of\ Rod}{Angular\ Velocity\ of\ Crank}$$

By substitution in (7) we obtain

$$Crankshaft\ couple = -\frac{I_c}{g}\,\frac{Ang.\ Acc.\ of\ Rod \times Ang.\ Vel.\ of\ Rod}{Ang.\ Velocity\ of\ Crank} \ldots (8)$$

Forces F_2 and F_3 acting vertically at wristpin and crankshaft center cause a frame couple equal to F_2 $(r\cos\theta + l\cos\phi)$ or substituting for F_2 in terms of T from (6)

$$Frame\ couple = \frac{T}{l\cos\phi}(r\cos\Theta + l\cos\phi) = T\left(1 + \frac{r\cos\Theta}{l\cos\phi}\right)$$

In the same manner as for the crankshaft torque, this can be reduced to the form

$$Frame\ couple = -\frac{I_c}{g}\left(Ang.\ Acc.\ of\ Rod + \frac{Ang.\ Acc.\ of\ Rod \times Ang.\ Vel.\ of\ Rod}{Ang.\ Vel.\ of\ Crank}\right) \ldots\ldots\ldots (9)$$

The approximate method, therefore, neglects the crankshaft and frame couples as given by equations (8) and (9) which we may call the corrective couples. As they stand, these equations are not easily evaluated, since they involve two variable quantities: The rod angular velocity and the rod angular acceleration. However, by an algebraic expansion they may be reduced to a Fourier series, whose only variables are functions of the crank angle, as follows:

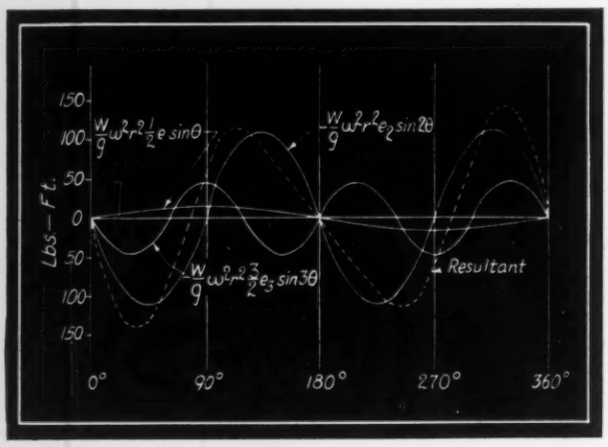


Fig. 5—Major harmonics of inertia torque by usual approximate method

$$Corrective\ crankshaft\ couple = -\frac{I_c\,\omega^2}{g}(s_2 \sin 2\Theta + 2\,s_4 \sin 4\Theta + \text{———}) \ldots\ldots (10)$$

$$Corrective\ frame\ couple = \frac{I_c\,\omega^2}{g}(u_1 \sin\Theta + s_2 \sin 2\Theta + 3u_3 \sin 3\Theta + 2s_4 \sin 4\Theta + \text{———}) \ldots (11)$$

The quantities u_1, u_3, s_2, s_4 are constants whose values depend on the ratio of crank length to connecting rod.

If this ration r/l is called n, then

$$s_2 = \frac{1}{2}n^2 - \frac{1}{32}n^6 - \frac{1}{32}n^8 + \text{———}$$

$$s_4 = -\frac{1}{8}n^4 - \frac{1}{16}n^6 - \frac{1}{32}n^8 + \text{———}$$

$$u_1 = n + \frac{1}{8}n^3 + \frac{3}{64}n^5 + \text{———}$$

$$u_3 = -\frac{1}{8}n^3 - \frac{9}{128}n^5 + \text{———}$$

The quantity n is usually from 1/3 to 1/5. Terms involving higher powers of n may be neglected with slight error, since they diminish in value rapidly.

In order to determine the importance of the errors due to the approximate method, the couples calculated by equations (10) and (11) should be compared with the couples due to reciprocating masses and to that portion of the connecting rod which is assumed to reciprocate as found by the approximate method outlined in the early part of this article.

If W represents the reciprocating masses, plus the weight W_1 for the connecting rod, then at any crank angle the accelerating force acting along the line of stroke is equal to

$$\frac{W}{g}\,r\,w^2\left[\cos\Theta + \frac{\cos^4\Theta + \cos 2\Theta\,(n^{-2}-1)}{(n^{-2} - \sin^2\Theta)^{3/2}}\right]$$

Or, reduced to a Fourier expansion it becomes

$$Accelerating\ force = \frac{W}{g}\,r\,w^2\,(\cos\Theta + 4\,q_2 \cos 2\Theta + 16\,q_4 \cos 4\Theta + 36\,q_6 \cos 6\Theta + \text{———}) \ldots\ldots\ldots\ldots (12)$$

This force acting at the wristpin produces a couple on the crankshaft and an equal but opposite couple on the engine frame which we will refer to as the inertia torques. Its value is

$$\frac{W}{g}\,r^2\,\omega^2\left(\frac{1}{2}e_1 \sin\Theta + e_2 \sin 2\Theta + \frac{3}{2}e_3 \sin 3\Theta + 2e_4 \sin 2\Theta + \text{———}\right) \ldots (13)$$

The quantities q_2, q_4, e_1, e_2, etc., have values dependent on n which, as stated before, is the ratio of the crank length to the connecting rod length. They are found as follows:

$$q_2 = \frac{n}{4} + \frac{n^3}{16} + \frac{15}{512}n^5 + \text{———}$$

$$q_4 = -\frac{1}{64}n_3 - \frac{3}{256}n^5 + \text{———}$$

$$q^6 = \frac{1}{512}n^5 + \text{———}$$

$$e_1 = 2\,q_2$$

$$e_2 = -\frac{1}{2} + 8\,q_2\,q_4 + 24\,q_4\,q_6 + \text{———}$$

$$e_2 = -2q_2 + 4q_4 \text{ ———}$$
$$e_4 = -2q_2^2 + 12q_2q_4$$

We shall next apply these equations to a 6-cylinder automobile engine used in a popular make of car. Data obtained from it follows:

Bore, 3⅛ inches; stroke, 4⅜ inches; connecting rod length, 7-15/16 inches; weight of rod, 1.98 pounds; weight of piston assembly, including rings and wrist pin, etc., 1.37 pounds. The center of gravity of the rod was found to be located at a point 2.0375 inches from the axis of the crankpin. For obtaining the weights W_1 and W_2 which are assumed to be reciprocating and rotating respectively, we obtain

$$W_1 + W_2 = 1.98 \text{ lbs. and}$$
$$W_1(7.9375 - 2.0375) = W_2 \times 2.0375$$

Solving for W_1 and W_2 we obtain $W_1 = 0.51$ pounds and $W_2 = 1.47$ pounds. The moment of inertia of this system of two weights is

$$I_b = W_1L_1^2 + W_2L_2^2 = 0.51 \times \left(\frac{5.9}{12}\right)^2 + 1.47 \times \left(\frac{2.0375}{12}\right)^2 = 0.166 \text{ in foot-pound units}$$

To obtain I_a, the moment of inertia of the actual rod, it was suspended by a knife edge through the wristpin bearing (0.86-inch diameter) and was found to make 134 oscillations per minute, giving a time per oscillation of 0.448 seconds. Hence by (3) we get

$$I = \frac{W l_0 g t^2}{\pi^2} = \frac{1.98(5.9 + 0.43)\,32.2\,(0.448)^2}{12 \times 0.987} = 0.685$$

and from (4)

$$I_a = I - W l_0^2 = 0.685 - 1.98\left(\frac{6.33}{12}\right)^2 = 0.134$$

$$\text{Hence } I_c = I_a - I_b = 0.134 - 0.166 = -0.032 \text{ in foot-pound units}$$

A checking value of I_a was obtained by suspending the rod from the crankpin end. This gave substantially the same result.

The next step was to calculate the crankshaft and engine frame torques by (10) and (11). The crank-connecting rod ratio n is 4.375/2x7.9375=0.276. Substituting this value of n in the equations for u_1, u_2, s_2, s_4, etc., we obtain u_1=0.27935, u_3=—0.00372, s_2= 0.0384 and s_4=—0.0007. Assuming an engine speed of 3200 RPM, W=2πx3200/60=335 radians per second.

Using (10),

$$\text{Corrective crankshaft torque} = -\frac{I_c\omega^2}{g}(S_2 \sin 2\theta + 2s_4 \sin 4\theta + \text{———})$$
$$= +\frac{.032\,(335)^2}{32.2}(.0384 \sin 2\theta - 2 \times .0007 \sin 4\theta \text{———})$$
$$= +4.29 \sin 2\theta - .151 \sin 4\theta$$

By (11)

$$\text{Corrective engine frame torque} = \frac{I_c\omega^2}{g}(u_1 \sin\theta + s_2 \sin 2\theta + 3u_3 \sin 3\theta + 2s_4 \sin 4\theta + \text{———})$$
$$= -\frac{.032 \times 335}{32.2}(.2593 \sin\theta + .0384 \sin^2\theta - 3 \times .00372 \sin 3\theta - 2 \times .0007 \sin 4\theta)$$
$$= -32.7 \sin\theta - 4.29 \sin 2\theta + 1.24 \sin 3\theta + .151 \sin 4\theta$$

These calculations indicate that the maximum error by use of the approximate method consists of a couple of about 4¼ foot-pounds on the crankshaft and something over 35 foot-pounds on the frame at the speed selected when considering one cylinder only. Whether this is negligible or otherwise can be determined by comparison with the couples calculated by (13). For this engine, W = weight of reciprocating masses plus the portion of the connecting rod considered as reciprocating, or W=1.37+0.51=1.88 pounds. Substitut-

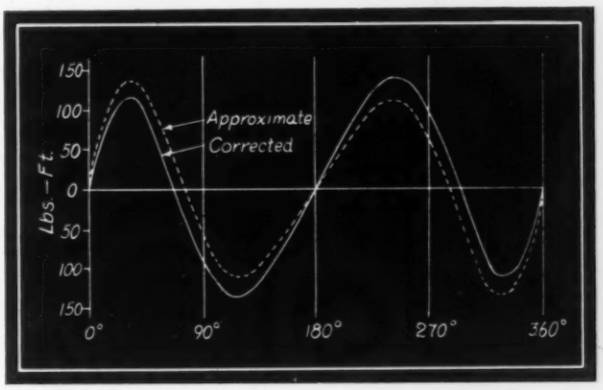


Fig. 6—Dotted curve is same as resultant curve of Fig. 5, but inverted as masses produce equal but opposite couples on crank and frame

ing the value 0.276 for n in the equations for determining q_2, q_4, etc., we obtain q_2=0.0703, q_4=— 0.00033 and q_6 = 0.000003. Using these values of q_2, q_4, etc., to find e_1, e_2, etc., we find e_1=0.1406, e_2=— 0.00033 and q_6 = 0.000003. Using these values of q_2, inertia couple, by substitution in (13) is

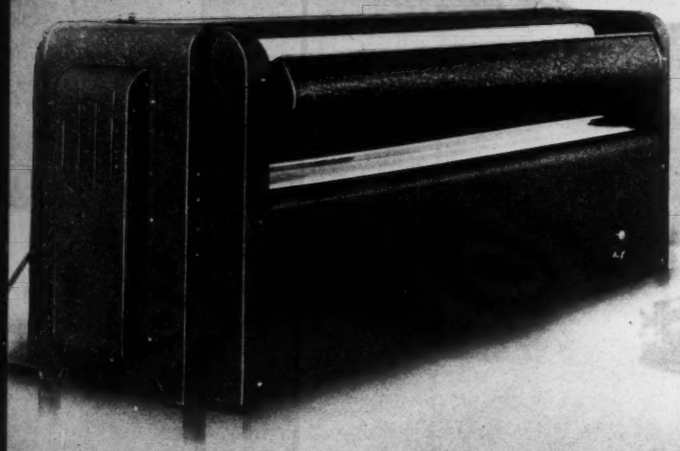
$$\frac{1.88}{32.2}(335)^2\left(\frac{2.1875}{12}\right)^2\left[\frac{1}{2} \times .1406 \sin\theta - .5002 \sin 2\theta - \frac{3}{2} \times .1408 \sin 3\theta - 2 \times .0101 \sin 4\theta\right] = 15.3 \sin\theta - 109 \sin^2\theta - 46.4 \sin 3\theta - 4.4 \sin 4\theta$$

Fig. 3 shows the two important harmonics, also the resultant for the crankshaft torque correction. In *Fig.* 4 are shown similar curves for the engine frame torque correction. *Fig.* 5 shows the major harmonics and the resultant inertia torque, from (13).

The dotted curve of inertia torque on the engine frame, *Fig.* 6, is of the same shape as the resultant curve of *Fig.* 5 but it is inverted. This is necessary because the acceleration of the reciprocating masses produces equal but opposite couples on the crank and frame. The solid curve of *Fig.* 6 shows the true torque, corrections as obtained from *Fig.* 4 having been applied.

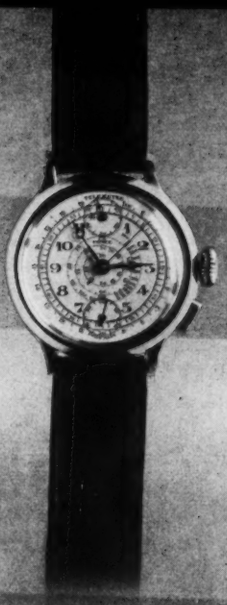
Comparison of the two curves of *Fig.* 6 indicates

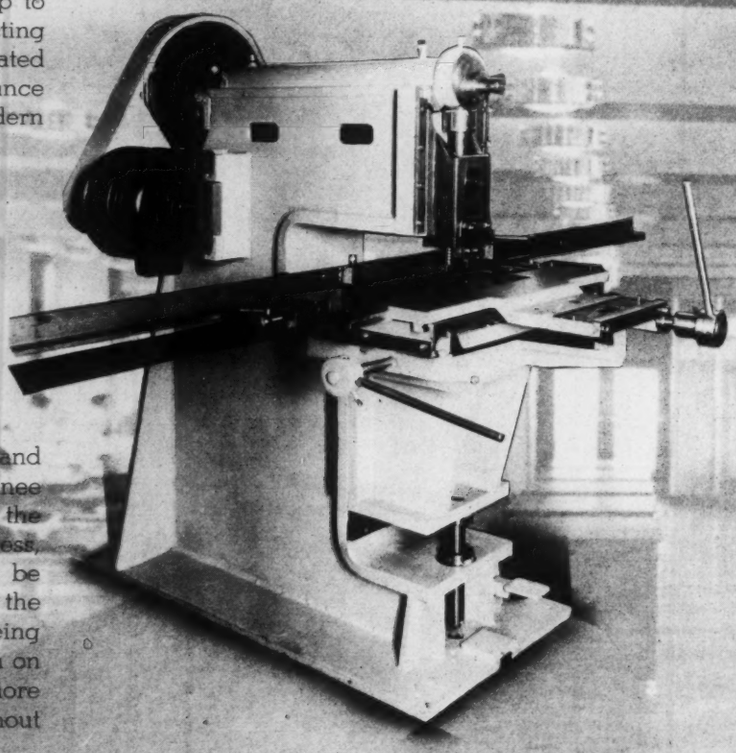
(*Continued on Page* 93)



Attractively finished, the new Bruning printing machine, above, exposes paper of any width up to 42 inches. Projecting parts have been eliminated to improve appearance and conform with modern design trends

Wrist watch, stop watch, tachometer and telemeter are combined into one instrument in this unusual mechanism, right. The Pierce wrist watch performs the functions of four instruments yet is no larger than the ordinary type



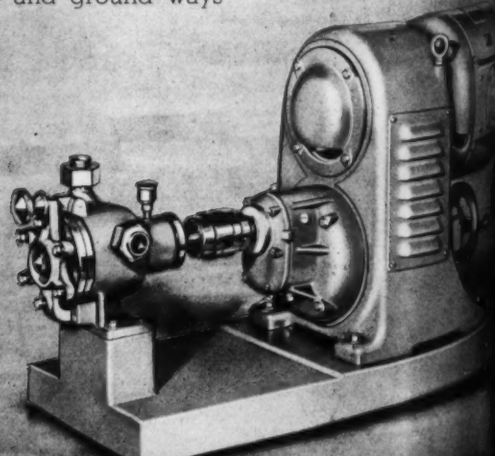


All-welded frame and welded adjustable knee beds distinguish the Service deep-throat press, right. Flywheels may be interchanged to suit the type of work being handled. Safety clutch on machine prevents more than one stroke without touching treadle

Design Fea
In New Ma

**A Pictorial Presentation of
from the Standpoint**

Hydraulically operated, the Colonial broaching machine, left, is built for easy manipulation, having controls on each side of the machine. Cross heads are provided with replaceable hard bronze shoes which travel on hardened and ground ways



Sleek in appearance the Schramm air compressor, below, is styled on automotive lines. Compressor features a vertical, four-cylinder block, five main bearings, force-feed lubrication and a self-aligning clutch between engine and compressor

Mercury switch automatically starts motor as carriage is lifted in the Dictaphone cylinder shaving machine, above, and stops mechanism when carriage reaches end of cylinder. Cutting knife is easily adjustable for extremely fine cuts

Ruggedly built, yet performing a delicate function, the Leeds & Northrop recorder, below, incorporates excellent design features. The indicating and recording device is direct driven through a worm gear to prevent any lost motion or backlash

ectures
Machines

of Recent Machinery
oint of Design

Pipes or reeds are not necessary in the Hammond electric organ, below, which, by means of a synchronous motor driving 91 small disks and inducing electric impulses, is able to produce 253 million tones. Infinite degree of volume is accomplished with an amplifying unit operated by a swell pedal

Pump housing, rotor and impellers are made of nickel alloy in the compact Pine-Ihrig pumping unit, left, allowing milk and other liquids to be circulated without contamination. A motorized variable speed device drives the pump

New Machines Indicate Design Trends

Making machines operate is not a major consideration of the engineer today. He knows machine purchasers take for granted that an accredited machine will run and is more interested in the ease with which it is controlled. Practically the entire gamut of mechanical devices have been used for remote control of machines. Wires, ropes, chains, extended levers and linkages are employed with varying success. For certain conditions these devices are satisfactory, but designers have found that electric or hydraulic control answers their needs most efficiently. Shifting gears, regulating variable speed units, changing airplane propeller pitch are a few examples of hydraulic applications to obtain sure and precise remote control. The advantages of fluid power are almost self-evident. In simple systems only two moving parts, a piston at the work and the control terminals, are necessary. Corners may be easily navigated, pipes may be run through thick walls and there is no chance of cables or ropes wearing on jagged edges when using hydraulic remote control.

Air Conditioning

Winter air conditioner, General Electric Co., Schenectady, N. Y.
Unit coolers, General Refrigeration Sales Co., Beloit, Wis.
Oil-fired alternating current unit, S. T. Johnson Co., Oakland, Calif.

Barber

Lather mixer, Rolstad Mfg. Co., Minneapolis.
Xervac treatment machine, The Crosley Radio Corp., Cincinnati.

Construction

Intensive clay mixer, National Engineering Co., Chicago.
Auxiliary, small-diameter, roll machine, Hercules Co., Marion, O.
Dump trailer, Athey Truss Wheel Co., Chicago.

Dairy

Pasteurizers, The Pfaudler Co., Rochester, N. Y.
Variable speed mixer, Mixing Equipment Co., Rochester, N. Y.
Spray pasteurizer, Cherry Burrell Corp., Chicago.
Milk coolers, General Electric Co., Nela Park, Cleveland.

Domestic

Oil burner, Herco Oil Burner Corp., Lancaster, Pa.
Attic ventilating fans, Viking Air Conditioning Corp., Cleveland.
Oil burning heater, Metal Door & Trim Co., LaPorte, Ind.
Coal stoker, Peerless Mfg. Corp., Louisville, Ky.
Electric iron, General Electric Co., Schenectady, N. Y.
Electric fan, Diehl Mfg. Co., Elizabethport, N. J.

Food

Portable fumigator, E. I. duPont de Nemours & Co., Wilmington, Del.
Nut roll machine, Savage Bros. Co., Chicago.
Electric cookers and boilers, Brannon Inc., Detroit.

Industrial

Lightweight, heavy duty, portable vacuum cleaner, U. S. Hoffman Machine Corp., New York.
Hosiery seamer, Union Special Machinery Co., Chicago.
Automatic powder feeder and mixer for plating trade, Industrial Filter & Pump Mfg. Co., Chicago.

Laboratory

Vacuum dryer, F. J. Stokes Machine Co., Philadelphia.

Materials Handling

Lift truck for paper handling, Towmotor Inc., Cleveland.
Telescoping truck, Baker-Raulang Co., Cleveland.

Metalworking

Hydraulic metal forming press, Farrel-Birmingham Co., Ansonia, Conn.
Milling machines, Brown & Sharpe Mfg. Co., Providence, R. I.
Grinding and polishing machine, Excelsior Tool & Machine Co., East St. Louis, Ill.
Abrasive cutting machine, American Chain & Cable Co. Inc., Bridgeport, Conn.
Sand conditioner, Beardsley & Piper Co., Chicago.
Ball bearing bench grinder, Black & Decker Mfg. Co., Towson, Md.

Mining

Multizone classifier, Dorr Co. Inc., New York.

Packaging

Continuous batching unit, Jeffrey Mfg. Co., Columbus, O.

Refrigerating

Evaporative condenser, Motor Equipment Co., Wichita, Kans.

Restaurant

Electric glass washer, Olson Mfg. Co., Minneapolis.
Frosted drink mixer, Freez-Master Co., Beloit, Wis.

Textile

Stainless steel piece dye kettle, Riggs & Lombard Inc., Lowell, Mass.
Metal wool washer, Riggs & Lombard Inc., Lowell, Mass.
Winding and measuring machine, Hermas Machine Co., Hawthorne, N. J.

Welding

Arc-welding machine, Hobart Bros. Co., Troy, O.

Will Television Be the Next Industry to Stimulate Prosperity?

BECAUSE the normal growth of the country and—synonymous with it—the return of real prosperity, are dependent largely on the development of new industries, it is inspiring to consider the comparatively imminent availability of satisfactory television equipment. Many sets are at present on trial and it is safe to say that within a year or so a boom such as experienced in the radio industry will again be felt.

Evidence of this is forthcoming from the fact that thousands of persons in the British Isles viewed the recent coronation through television machines with far greater satisfaction than if they had actually been present. Furthermore, we understand it is common practice, whenever a new movie theater is built in that country, to equip it for the adaptation of television as and when the system is more highly perfected.

Our leading manufacturers are, of course, fully aware of the developments taking place elsewhere and are entrenching themselves for the demand that will follow the announcement of reasonably-priced models. That this may be stupendous, with a highly beneficial effect upon other companies producing materials, parts and accessories, can readily be foreseen if every home, as with radio, is to have its own television receiver. To machinery—and designers—will again be due the credit if this is not too visionary forecast comes true!

• • •

Rubber Takes Its Place

THERE probably has never been a previous period when the application of rubber as a machine part has increased so rapidly as during the past two or three years. As a protective medium for the coating of metal, as a vibration dampener for machine mountings, and as a spring material for vehicles, its qualities have become widely recognized.

Synthetic rubber, possessing the qualities of actual rubber to a marked degree, has played a prominent part in this development. Resistant to oil, the newer material fills a gap not completely bridged by the old. The two together will find, as time goes on and a still better understanding of their properties is gained, a place among engineering materials that will warrant their serious consideration by designers of virtually every type of machine. It is because of this imminent possibility that MACHINE DESIGN has devoted considerable space to this subject, both in the current issue and in the previous issue for May.

Professional Viewpoints

MACHINE DESIGN WELCOMES LETTERS SUITABLE FOR PUBLICATION

Mr. Rantsch's Gearing Made Easy

To the Editor:

IN THE January issue of MACHINE DESIGN, Mr. E. J. Rantsch explained in "Professional Viewpoints" two examples of compound planetary gearing which utilized only external gears. When these examples are generalized, we have the following equations for the ratio of the driver to the driven gear:

In case No. 1, *Fig.* 3, with gear C fixed, let R be the ratio of D, the driver, to arm F, the driven member. Then

$$R = 1 - \frac{B\,C}{A\,D}$$

From this equation we see that when R is positive, gear D and arm F revolve in the same direction. When R is negative D and F revolve in opposite directions.

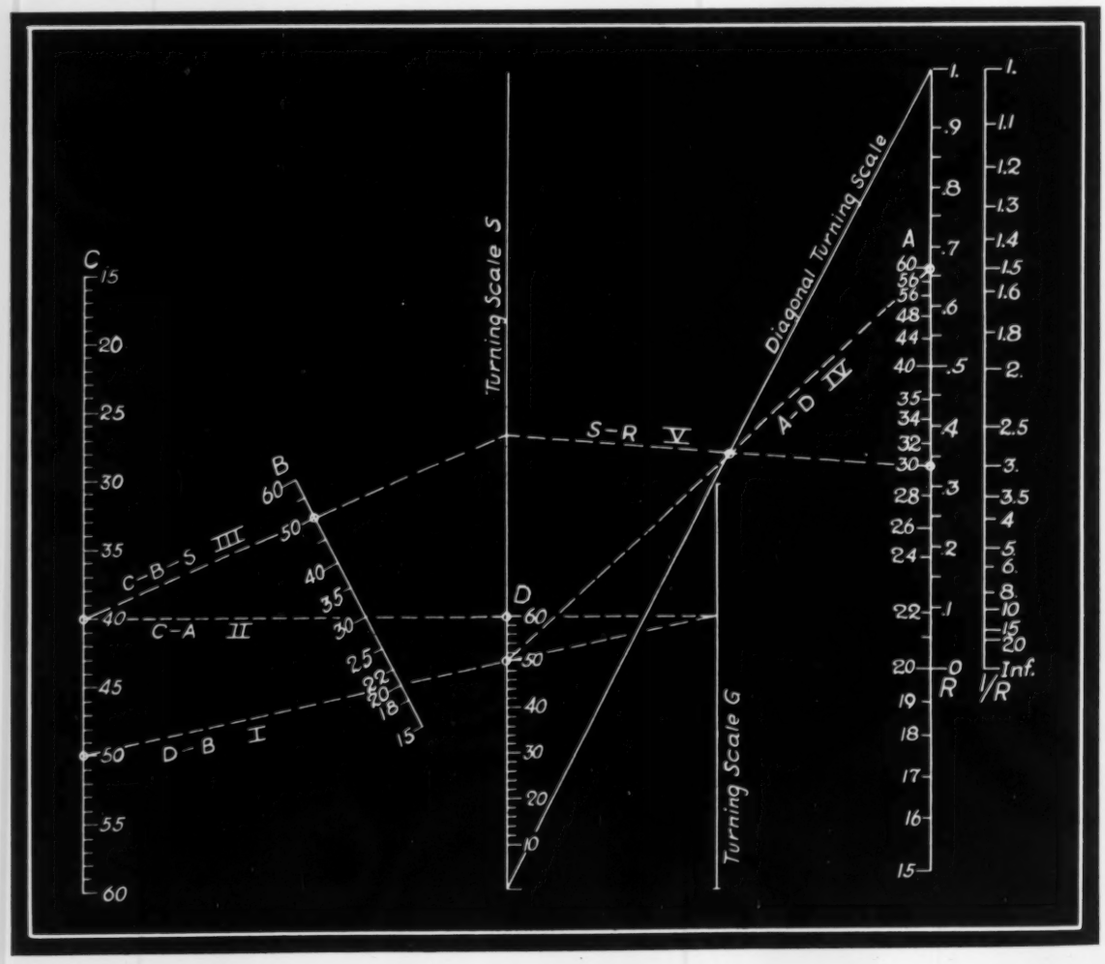
For case No. 2 in which gear D is fixed, we will let r be the ratio of C, the driver, to arm F, the driven member. Then

$$r = -1 + \frac{A\,D}{B\,C}$$

and when r is negative C and F revolve in the same direction, when r is positive C and F revolve in opposite directions.

In both of these examples gears A and B are keyed to each other and revolve as one. Therefore from the

Fig. 1—Nomogram permits graphical solution of planetary gear train problems



above equations, we see that

$$R = \frac{r}{1+r} \text{ or } r = \frac{R}{1-R}$$

The equation of meshing is $A + C = D + B$. In the foregoing A, B, C and D represent either the number of teeth, pitch diameter, or radius of each gear.

It is easy to understand that if the second term in

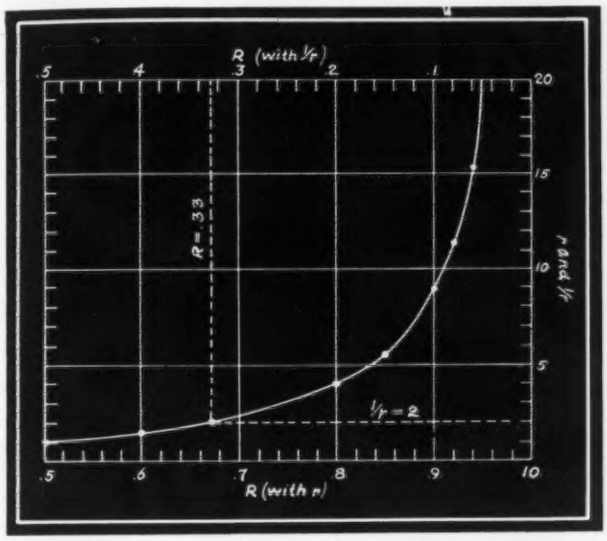


Fig. 2—Relations of gear ratios in Case No. 1 and Case No. 2 may be obtained from this curve

either of the ratio equations is nearly unity, then R or r will be very small, or $1/R$ and $1/r$ very large. In case No. 2, if we make $A = 29$ teeth, $D = 31$, $B = 30$, then C must have 32 teeth to satisfy the meshing equation.

Using these numbers, we find $r = -1 + 29 \times 31/30 \times 32$ making $1/r = -15.63$. Thus we have a high reduction with only four gears, all nearly the same size. This is desirable and quite possible as the equation of the gear ratio contains a negative sign which characterizes differential gearing.

The writer has made the first of the ratio formulas, for case No. 1, into a nomogram shown in *Fig.* 1. This can be used for quick graphical solution when the teeth of any three of the four gears are given to find the fourth, and the ratio R and its inverse $1/R$. From the curve, *Fig.* 2, r may be found from R.

As an example of the use of the nomogram, assume D and B each have 50 teeth, and A, 60. Draw secant I through 50 on each scale, as shown, continuing it to the turning scale G, and then back through 60 as secant II. The latter cuts the C scale at 40 which is the number of teeth for gear C. If preferred, C may be obtained from the meshing equation. Draw secant III from 40 on C through 50 on B to turning scale S. Now draw secant IV from 60 on A to 50 on D, cutting the diagonal turning scale. Draw secant V through the above point on S and through the intersection on the diagonal turning scale. This, extended,

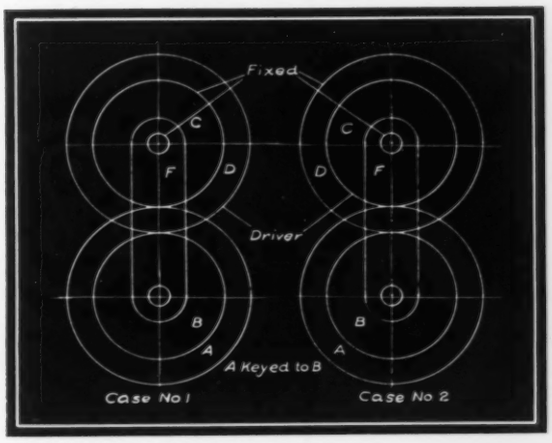


Fig. 3—Gear trains arranged in this manner permit high reduction with only four gears

cuts scale R at .33, which is the required gear ratio. On the scale for $1/R$, the latter is 3. Note that on *Fig.* 1 the calculating secants are discontinued where there are no significant intersections, these being marked by small circles.

From the hyperbolic curve, *Fig.* 2, or its equation, $r = R/1 - R$, there is obtained $1/r = 2$, or $r = \frac{1}{2}$ for case No. 2 instead of from the nomogram.

For those interested in the construction of *Fig.* 1, this nomogram solves two equations by means of five lines. It consists of six graduated scales for A, B, C, D and $1/R$, and two turning scales, S and G and the diagonal, all being laid on two Z-charts, the latter computed by secants III, IV and V. Combined with these two charts is a parallel line chart with graduated scales, C and D, now utilized twice, and turning scale G, computed by secands I and II.

—CARL P. NACHOD
Vice President, Nachod & U. S. Signal Co.

Are We Inconsistent?

To the Editor:

SOMEHOW or other in looking through the May issue of MACHINE DESIGN I turned directly from page 26 to page 47. Under "Topics" on page 26 you mention the installation of a "miniature loud speaking system" to enable bus drivers to hear the engine in rear-engined busses to facilitate gear shifting. This seems a little incongruous in view of the feature article on page 47 which describes a transmission that shifts automatically. Of course, I appreciate that this difficulty in changing gears is one of the reasons why automatic transmissions are considered with such favor by rear-engine vehicle manufacturers. On the other hand, I also realize that all automatic transmissions cannot be shifted without some form of synchronization unless they are provided with an automatic clutch as is the case in the automatic transmission you describe on page 47.

—A. F. DENHAM
Detroit

MEN of MACHINES

ANNOUNCEMENT is made of the nomination of Harvey N. Davis, president of Stevens Institute of Technology, for the presidency of the American Society of Mechanical Engineers.

Dr. Davis, who was born at Providence, R. I., in 1881, graduated at Brown University in 1901 with an A. B. degree and in 1903 and 1906 respectively was awarded A. M. and Ph. D. degrees by Harvard university. Beginning his teaching career at Brown immediately following graduation, he was an instructor at Harvard from 1904 to 1910, when he became assistant professor of physics. He was made professor of mechanical engineering at Harvard in 1919, serving until his election as president of the Stevens institute in 1928.

Dr. Davis is widely recognized as an authority on thermodynamics.

HARVEY N. DAVIS

• • •

WILLIAM T. CROWE, general manager of the new diesel engine division, General Motors Corp., Detroit, has an unusual background of technical experience.

A native Detroiter, Mr. Crowe received his M. E. degree from University of Detroit in 1916, then joined the Hudson Motor Car Co. Detailed to McCook Field in 1918, he was sent to France to study aviation engineering methods. When the war ended he returned to Hudson.

From 1920 to 1925 Mr. Crowe was chief engineer, engine division, General Motors of Canada, then became Detroit office manager of General Motors export division. A year later he was sent to Germany on redesign of the Opel car for manufacture by General Motors. From 1929 until his recent promotion he worked in Detroit with O. E. Hunt, vice president in charge of engineering.

WILLIAM T. CROWE

• • •

AWARD of the John A. Penton Medal has been made to John W. Bolton in recognition of his work in metallurgy and his practical application of research findings to the advancement of the foundry industry.

Mr. Bolton has been engaged continuously in metallurgical and research work since his graduation from Rose Polytechnic institute in 1918. His college made him a Master of Science in 1921 and Honorary Chemical Engineer in 1925. He also has been a member of Sigma Xi at the University of Cincinnati.

He has served as chemist for the Procter & Gamble Co. both at Kansas City and at Cincinnati; as metallurgist for the Niles-Bement-Pond Co., Hamilton, O., and for the Frank Foundries Corp., Moline, Ill.; and at present he is chief chemist and metallurgist for the Lunkenheimer Co.,

JOHN W. BOLTON

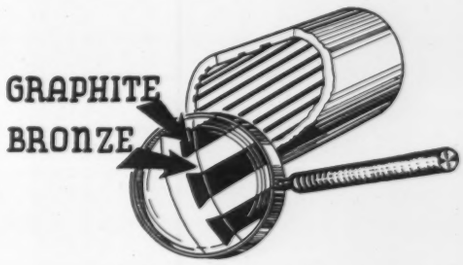
Sleeve BEARING HEADQUARTERS

SELF-LUBRICATING
Sleeve-type Bearings

THE combining of graphite compound, in a permanent manner, with the modern sleeve bearing is growing more in favor every day. Especially is this true in applications where lubrication is difficult, likely to be neglected or where the speed is too slow that no film of ordinary lubricant can be sustained.

This is an ideal bearing for applications such as textile or food machinery where fluid lubrication will spoil goods in process. Also it is favored for household appliances where the service is intermittent and where ordinary lubrication is undesirable or likely to be forgotten.

In a graphited bearing, the first few revolutions of the shaft imparts a thin layer portion of the graphite compound to both the shaft and the bearing. This action provides a rubbing surface that is as smooth as is possible to achieve. Naturally this reduces friction to a minimum. We do not recommend this type of bearing for applications that involve constant use with a shaft speed of over 30 feet per minute.

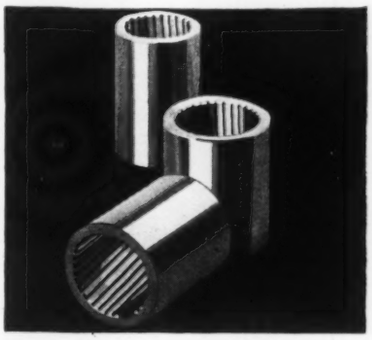


Graphite Held Permanently in Place

The Johnson method of applying graphite to bearings assures the permanency of the construction. The dovetailed grooves are cut at a lead of 7 degrees in order to provide an alternating layer of bronze and graphite contact.

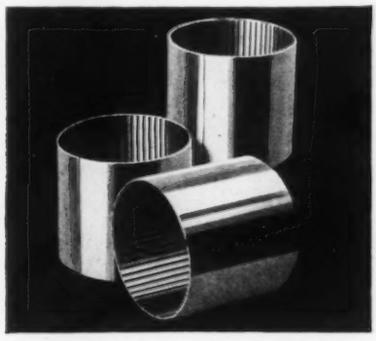
The dovetail construction of the groove itself prevents the graphite from coming out.

The graphite compound is not soluble in water, gasoline or grease and is in no way harmful to the metal of the bearing or the shaft.



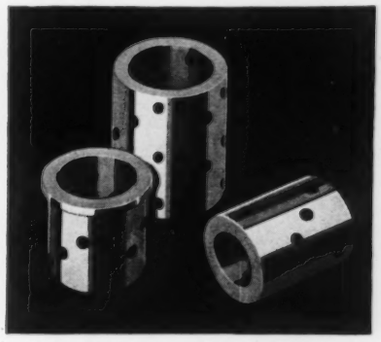
Cast Bronze Graphited

Dovetailed grooves are CUT into the bearing surface at a lead of 7 degrees. This type of self-lubricating bearing is available in practically all of our stock size bearings.



Sheet Bronze Graphited

In this type, the serrations are CUT into the bearing surface before the metal is formed into the bearings. This particular type is in great favor with the automotive industry. Naturally, quantity of a size governs the economy of sheet metal bearings.



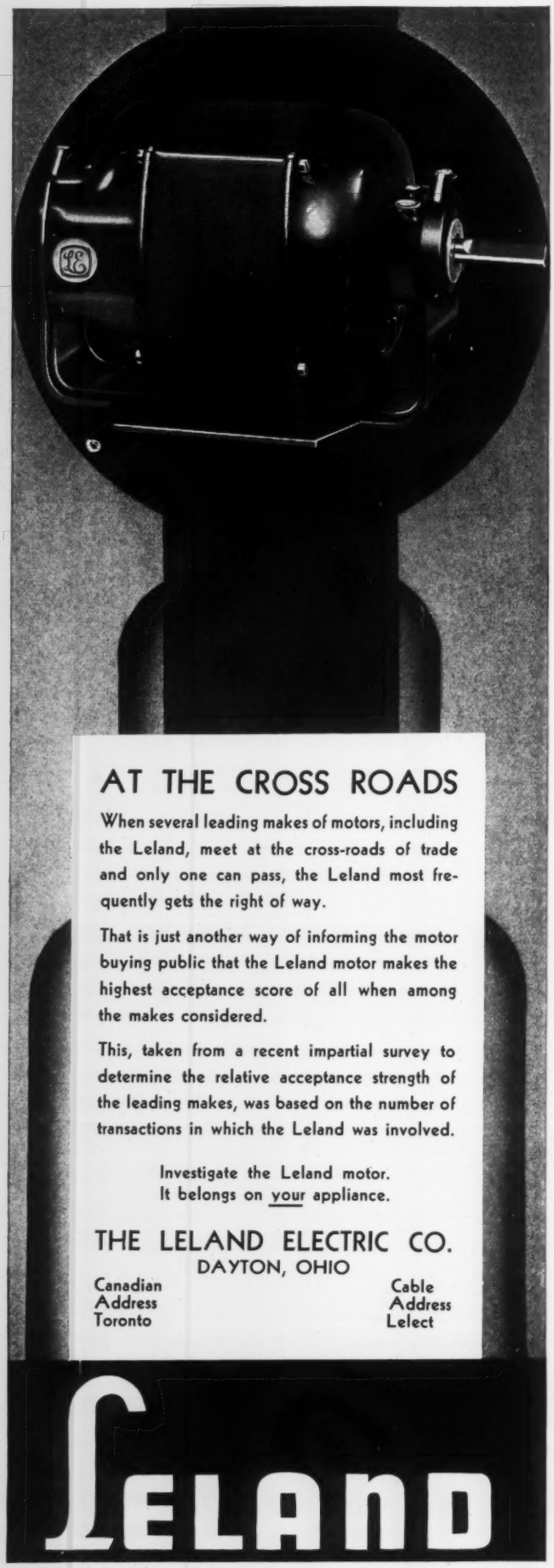
Plug-Type Graphited

In order to meet those conditions involving excessive heat we have developed this plug type graphited bearing. In specifying plug type, consideration must be given to the alloy of the bronze so that the bearing material will likewise be suited to the application.

WRITE TODAY . . . FOR FREE DESCRIPTIVE LITERATURE

JOHNSON BRONZE COMPANY
525 SOUTH MILL STREET • NEW CASTLE, PA.

Sleeve BEARING HEADQUARTERS


AT THE CROSS ROADS
When several leading makes of motors, including the Leland, meet at the cross-roads of trade and only one can pass, the Leland most frequently gets the right of way.
That is just another way of informing the motor buying public that the Leland motor makes the highest acceptance score of all when among the makes considered.
This, taken from a recent impartial survey to determine the relative acceptance strength of the leading makes, was based on the number of transactions in which the Leland was involved.
Investigate the Leland motor.
It belongs on your appliance.
THE LELAND ELECTRIC CO.
DAYTON, OHIO
Canadian Address Toronto
Cable Address Lelect
LELAND

Cincinnati. At the latter company he has been active in the development of non-cracking, age-hardening alloys, as well as a number of ferrous and nonferrous alloys for high temperature service.

In connection with the American Foundrymen's association, Mr. Bolton has carried out important gray iron and nonferrous investigations, and numerous papers and committee reports have been presented under his direction.

♦ ♦ ♦

DR. GILBERT E. DOAN, formerly associate professor in the metallurgical engineering department at Lehigh university, has been promoted to the position of full professor of metallurgy.

♦ ♦ ♦

HARRY A. WHITTAKER has been appointed chief engineer of the Micromatic Hone Corp., Detroit. He was at one time associated with Ex-Cell-O Aircraft & Tool Corp., and has done much consulting work on tool design for automobile and aircraft engines.

♦ ♦ ♦

KARL B. DANILOFF has joined the staff of Laucks Laboratories Inc., Seattle, Wash., where he will specialize on work concerned with synthetic resins.

♦ ♦ ♦

G. R. HARRIS has been transferred from the Aliquippa works metallurgical department of the Jones & Laughlin Steel Corp., to the company's new research and development division at Pittsburgh, where he will supervise patent work and technical publicity.

♦ ♦ ♦

WILLIAM S. KNUDSEN, formerly executive vice president of General Motors Corp., has been elected president, succeeding Alfred P. Sloan Jr. who has been made chairman of the board. Mr. Knudsen, long recognized for his outstanding genius in the technique of mass production, is well known throughout the entire engineering field.

♦ ♦ ♦

G. WAINE THOMAS, employed by the Reo Motor Car Co. for the past eleven years on truck and bus engineering, has been made chief engineer of the company.

♦ ♦ ♦

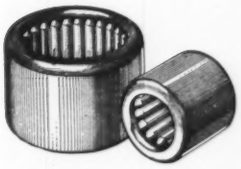
HENRY P. GEORGE, a graduate of Lehigh university in 1935 and a research fellow in the department of metallurgy and metals research laboratory at the Carnegie Institute of Technology, has received a Charles A. Coffin fellowship from the General Electric Co.

♦ ♦ ♦

RICHARD T. ERBAN, consulting engineer, has received from the Franklin Institute of Philadelphia one of the Edward Longstreth medals. This award is in consideration of Mr. Erban's "- - -invention and development of the Transitorq, a practical and useful variable speed transmission unit."

This new bearing is

Surprisingly Low in Cost



LOW FIRST COST PLUS OTHER ECONOMY FEATURES MAKE A COMPARATIVELY INEXPENSIVE, ANTI-FRICTION UNIT— A REQUIREMENT OF THE IDEAL BEARING

COMPARED to other types of anti-friction bearings, the Torrington Needle Bearing is surprisingly low in cost. Although it is made to sell at approximately a fourth the cost of a ball bearing of comparable rating, the initial cost is but one of the contributing factors in the economies it offers. Others made possible by the compact unit design of the Needle Bearing are equally important.

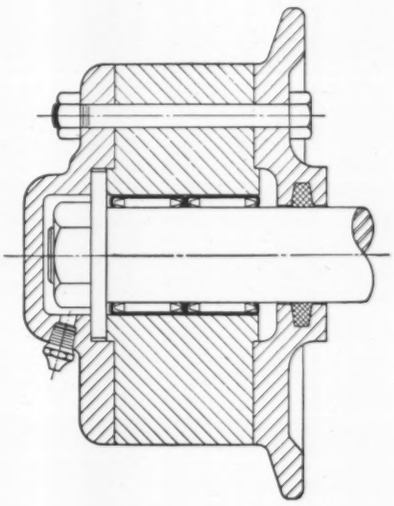
These Plus Features Contribute to Lower Costs

For example, consider the compact design of the bearing. No more space is required for installation than for a bronze or babbitt bushing. Its small outside diameter and high load capacity combine to simplify design, installation and construction details. Complicated and intricate housing structures are eliminated, resulting in direct saving in cost of materials and in reduction of needless weight of surrounding members.

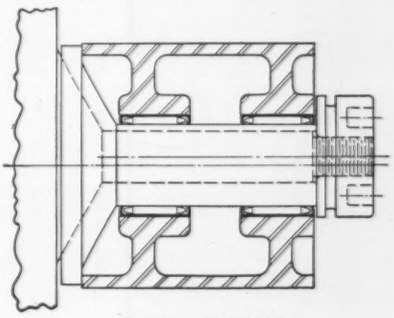
Then there is the additional advantage of simplicity of installation which lowers manufacturing costs. The increase in speed of assembly and saving in manual operations would delight the time-and-motion-study engineer.

And, too, the efficient lubricating action affects cost in another way. It prolongs the life of the bearing under the most severe conditions. Once placed in operation, it requires a minimum of service attention, creates customer satisfaction, lessens complaints and reduces costly returns.

All of these factors become tangible values in the cost accounting of the production line. Perhaps only a minor change in the design of your product will enable you to take advantage of these important cost savings. A Torrington representative will be glad to go over the possibilities in adapting the Needle Bearing. Complete information is given in Catalog No 9, available on request.



RAIL WHEEL



ROTARY PRINTER

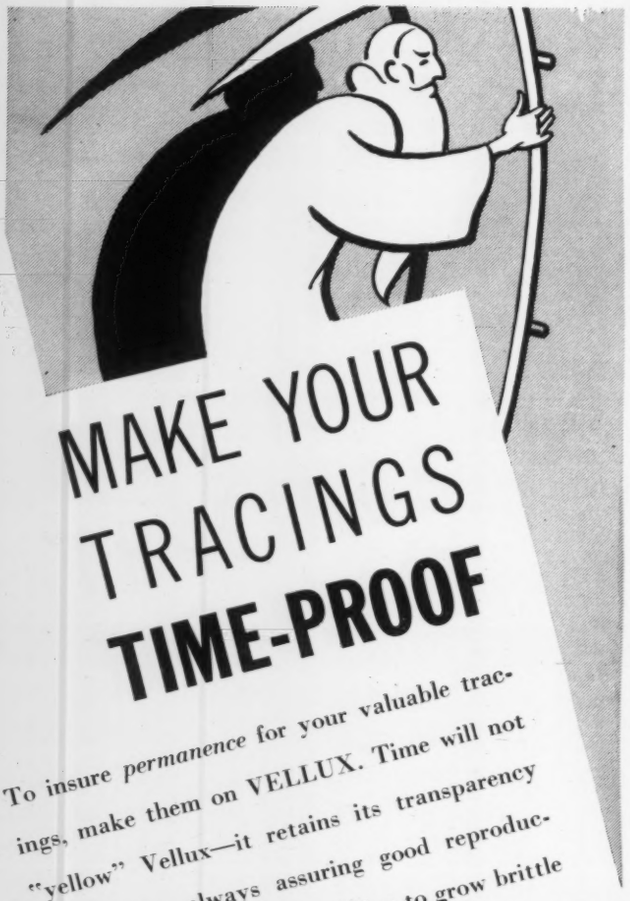
Reduced Manufacturing Costs May Result Directly from a Design Modified to Accommodate the Torrington Needle Bearing.

FEATURES OF THE TORRINGTON NEEDLE BEARING

Small Size — Ease of Installation
Efficient Lubrication — Low Cost
High Radial Load Capacity

The Torrington Company
ESTABLISHED 1866
Torrington, Conn., U.S.A.
Branch Offices in all Principal Cities

TORRINGTON
NEEDLE BEARING



MAKE YOUR TRACINGS TIME-PROOF

To insure *permanence* for your valuable tracings, make them on VELLUX. Time will not "yellow" Vellux—it retains its transparency indefinitely, always assuring good reproductions. Age will not cause Vellux to grow brittle or crack—you need never fear that your tracings will "go to pieces" in file or under handling.

Vellux, too, is always pleasant to use, because there is no annoying odor. This superior vellum tracing paper costs no more than ordinary vellums. A generous sample of Vellux is yours for the asking. Mail the coupon!

BRUNING Since 1897

New York Chicago Los Angeles Boston Detroit Houston
Kansas City Milwaukee Newark Pittsburgh St. Louis San Francisco

CHARLES BRUNING COMPANY, INC. 802
102 Reade St., New York, N. Y.

Gentlemen: I want to try VELLUX, the time-proof tracing paper. Please send me, without obligation, a generous working sample.

Name.....

Company.....

Address..... *City*..... *State*.....

Electrical Meetings Attract Engineers

BASED upon the same idea as that of putting a successful theatrical production "on the road" for the purpose of bringing it to a number of metropolitan centers, a dramatic presentation of developments in electrical drive and control and in cemented tungsten carbide cutting tools has been brought direct to important centers of the machine tool industry.

Conceived by General Electric Co., Schenectady, N. Y., and produced in collaboration with the Carboloy Co. Inc., Detroit, this traveling "Machine Tool Speed Show" opened at Hotel Bancroft, Worcester, Mass., May 17, was presented at Hotel Gibson, Cincinnati, May 24, and completed its scheduled itinerary with a closing performance at Hotel Faust, Rockford, Ill., May 28.

Featuring a large cast of engineers and application specialists from its sponsoring companies, assisted in each case by well known machine tool men, the show on all three occasions drew attendance of well over 100. Electrical equipment was on exhibition.

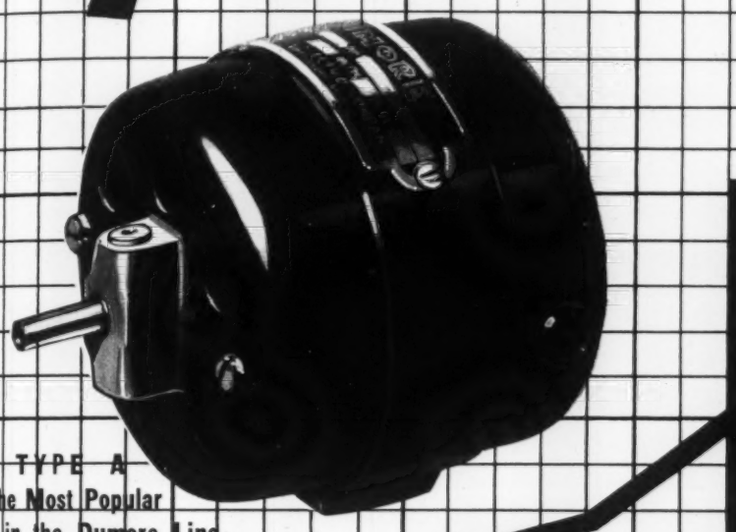
Praises Individual Drive

Sol Einstein, vice president and chief engineer, Cincinnati Milling Machine Co., Cincinnati, covered the subject of "Requirements of Electrical Equipment for High-Production Machine Tool Performance." As an index of the rising tide of electrification, Mr. Einstein mentioned that today less than 1 per cent of the machines built by his company are equipped for other than individual motor drive. Speaking particularly of conditions met with in the automobile industry, Mr. Einstein said, "Individual motor drive for machine tools permits the location and relocation of the tools to the best advantage with respect to their efficiency and the routing of work through the shops."

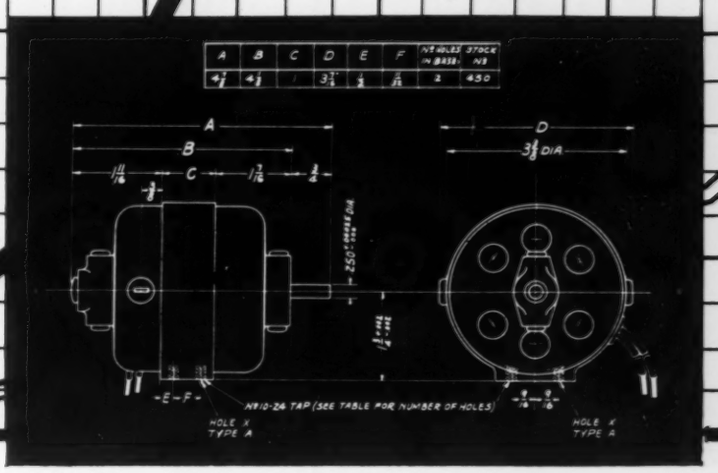
Among other papers, "Meeting Your Requirements for Motors," read by R. S. Walsh, motor division, General Electric Co., Schenectady, aroused lively discussion. The principal points brought out by the machine tool men were that from their point-of-view commercial grade motors in general still leave something to be desired in the way of accuracy of the feet and in quality of finish.

As an instance of the service demanded of control devices on machine tools, N. L. Hadley, also of Schenectady, cited the case of the control on a tapping attachment in an automobile plant which in a two weeks period operated 1,000,000 times. Ruggedness and long life therefore are prime necessities and the policy now is to make up a few sample devices for operating trials in users' plants before putting new things of this kind on the market, said Mr. Hadley.

HERE'S WHY YOU GET MORE *Power Hours* IN A DUMORE MOTOR



TYPE A
The Most Popular Motor in the Dumore Line



SPECIFICATIONS
TYPE A MOTOR

Class of Motor	Plain Series (Universal)
Construction Details—	
Degree of Enclosure	Open
Method of Cooling	Internal Fan
Bearings	Composition Bronze
Lubrication	Wick feed from oil wells
Direction of Rotation (Commutator End)	Clockwise
Housing Material	Cast Iron
Weight	3 lb.

Rating (Full Load, Continuous Duty)	A.C. Operation	D.C. Operation
Volts	115	115
Amperes	.72	.80
Watts, Input	69	96
Horsepower	1/30	1/20
Torque (Lb.-Ft.)	.027	.048
Full-Load R.P.M.	7,000	6,000
No-Load R.P.M.	20,000	20,000
Efficiency	39.5%	42.5%
Duty	Continuous	Continuous
Temperature rise	40°C.	40°C.

TYPICAL APPLICATIONS

Blowers
Motion Picture Projectors
Embroidery Machines
Yarn Testers
Surgical Pumps
Commutator Undercutters
Jewelers' Lathes

POSSIBLE MODIFICATIONS*

Other than 115-volt winding
C.C.W. or reversible rotation
Other than standard rating
Shunt winding for d.c. service
Other than standard shaft extension
Other than standard housing finish
Cast aluminum housing

*Note:—All modified motors are special. Prices on request.

Dumore motors *definitely differ* from ordinary motors —*Vibration is eliminated* by dynamically balancing armatures at high speed—*Five-time inspection* of parts, plus engineering inspection assures utmost accuracy —*100% electrical contact* of commutator leads is assured by special Dumore swaging—*Brush life is increased* by grinding commutator concentric with bearings—*Forced ventilation* is built into motor—*Centrifugal breathing is eliminated* by expanding armature windings at high speed and then sealing—*Wide selection* allows for meeting exact requirements (1/500 to ¾ h.p.—A.C. or D.C.—0 to 60 cycles). "Tailored-to-fit" parts may be had for special adaptations.

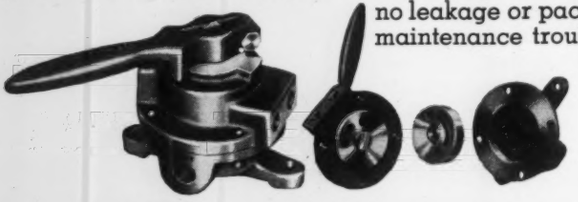
Write for latest catalog and Engineering Service blank. Let Dumore engineers show you how to get more power hours for the money invested.

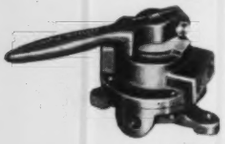
THE DUMORE CO., Dept. 127-F RACINE, WIS.

DUMORE
FRACTIONAL HORSEPOWER
MOTORS

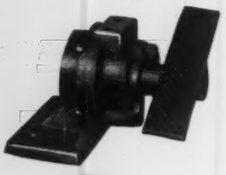
For POSITIVE CONTROL of AIR POWER

Hannifin disc-type Air Control Valves give the positive and accurate control of air operated equipment needed for economical, maximum production. Fast, smooth operation, and easy handling are combined with full utilization of air power. These valves have no packing, and no leakage or packing maintenance troubles.



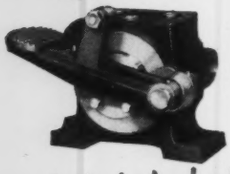


● **SIMPLE "PACK-LESS" DESIGN:** Hannifin disc-type valves have but four parts and a handle—there is no packing. The bronze disc is ground and lapped to make a perfect seal with the seat. Re-lapping at long intervals maintains efficient, leak-proof operation.



● **STANDARD HAND CONTROL VALVES:** Four-way type for control of double-acting cylinders, for air or hydraulic pressures to 150 lbs./sq. in. Four standard types, 45 or 90 degree movement. May also be used for three-way control of single-acting cylinders. Also duplex types for control of two double-acting cylinders.

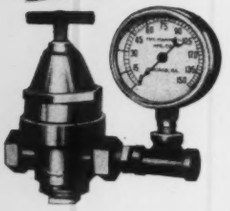
● **PEDAL OPERATED VALVES:** Operator's hands are free for other work. With 45 degree movement, no shut-off position. With 90 degree movement, both outlet and exhaust closed in neutral. May be used as a throttling valve.



● **SPRING RETURN VALVES:** Give instant reversal of cylinder upon release of pedal. With 45 degree movement, no shut-off position.

● **ROTARY TYPE VALVES:** Heavy duty foot operated ratchet action. One pressure operates the cylinder, second pressure reverses the cylinder.

● **MANIFOLD TYPES:** Concentrate control of several cylinders, with easier handling and simplified piping. Four standard types, 45 or 90 degree movement, and spring return types, for various cycles of control.



● **ELECTRIC TYPES:** Single and double electrically operated valves for remote control, time cycle operation, four-way control, for a variety of standard and special applications.

● **PRESSURE REGULATING VALVE:** A spring loaded piston type pressure reducing valve, correctly designed for accurate, sensitive, automatic control. Instantly adjusted to provide the most economical working pressure for any individual machine or operation.

Write for Valve Bulletin 34-MD with complete listings of all types

HANNIFIN MANUFACTURING COMPANY
621-631 South Kolmar Avenue, Chicago, Illinois
ENGINEERS • DESIGNERS • MANUFACTURERS
Pneumatic and Hydraulic Production Tool Equipment

HANNIFIN "Packless" AIR CONTROL VALVES

Noteworthy Patents

WITH increasing use of electric motors in such places as laundries, dairies, chemical plants, etc., the problem of safe and adequate ventilation has become more and more difficult. To meet this situation an improved motor housing recently has been developed by Victor L. Darnell of Dayton, O. The patent covering this housing has been assigned to Master Electric Co., Dayton.

Reference to *Fig.* 1 will give an idea of the system of air ducts and baffles by means of which air is drawn in at the two heads of a squirrel-cage motor and discharged at the center of the casing, after having passed through and around the stator or field element as well as through and around the rotor. The path of air is clearly indicated by the arrows on the diagram.

The theory on which Mr. Darnell has worked in developing his system is that the intakes and ducts should be laid out in such a manner that water or particles of grit must follow an unnatural course in case they get past the down-turned ports. In doing so, however, the inventor has taken pains to see that difficult foundry or manufacturing problems are not introduced. For instance the circulation of air is maintained in large volume by simple impeller blades at each end of the rotor.

The main feature of this motor is the ventilator ring which surrounds the stator element and which merges into the feet at the bottom. This can be seen in cross section at the top center of the diagram and its outside appearance is shown on the lower (unsectioned) part of the case. Not only is this ring baffled, but also the passage of air through its vents is so rapid

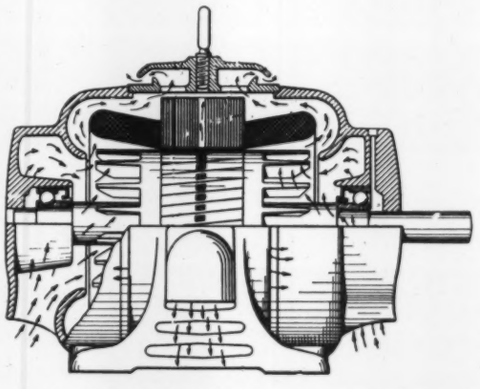
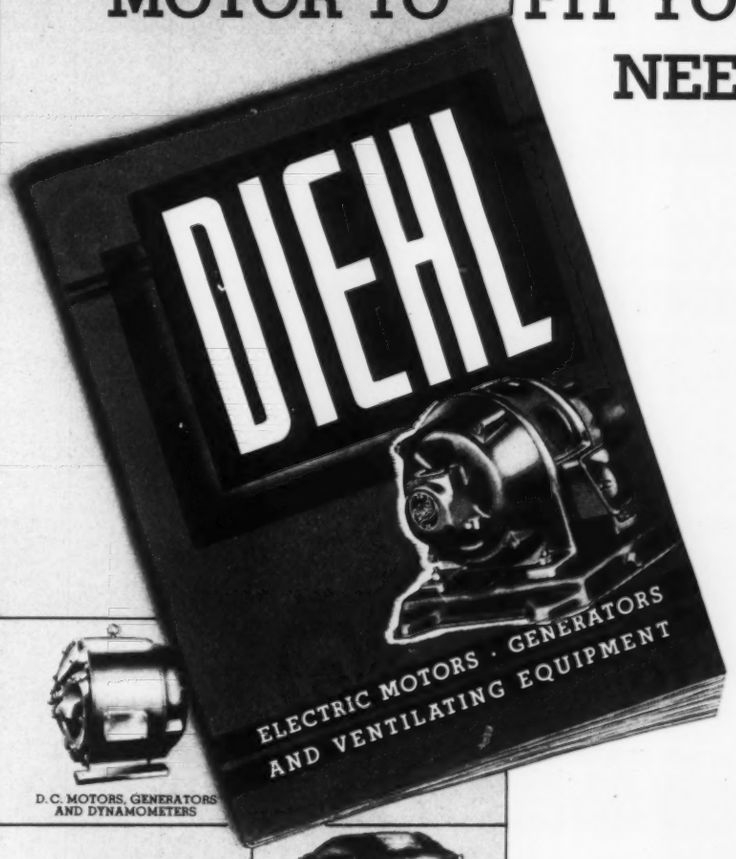


Fig. 1—*By forcing air to follow a devious path, water and grit are kept out of motor*

SELECT THE EXACT MOTOR TO FIT YOUR NEEDS

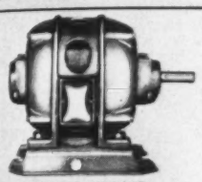


TYPICAL DIEHL APPLICATIONS

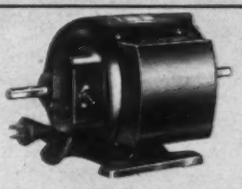
ADDING MACHINES
AIR CONDITIONING MACHINERY
AGITATORS
BAKERS' MACHINERY
BALANCING MACHINES
BATTERY CHARGING SETS
BLOWERS
BOTTLING MACHINERY
CALCULATING MACHINES
CAMERAS & PROJECTING EQUIP'T
CANDY MAKING MACHINES
CANNING MACHINERY
CEMENT MAKING MACHINERY
CHEMICAL PLANT MACHINERY
CHURNS
CIGARETTE MAKING MACHINES
CIRCULATORS, AIR
CLAY MAKING MACHINES
COAL MACHINERY
COKE MACHINERY
COFFEE MACHINERY
COMPRESSORS
CONVEYORS
CRANES
DAIRY APPARATUS
DENTAL MACHINES
DISHWASHERS
DRIERS
ELECTRO-PLATING EQUIPMENT
ELEVATORS
ESCALATORS
FANS, EXHAUST
FIRE ALARM SYSTEMS
FLOUR MILL MACHINERY
FOOD PROCESSING MACHINERY
GENERATING EQUIPMENT
GLASS MAKING MACHINERY
GRINDING MACHINERY
HOISTS
HYDRAULIC MACHINERY
LAUNDRY MACHINERY
LOOMS, TEXTILE
MACHINE TOOLS
DRILL PRESSES
PUNCH PRESSES

TYPICAL DIEHL APPLICATIONS

MACHINE TOOLS CONT'D
SHAPERS
GRINDERS
BORING MILLS
PLANERS
LATHES
SHEARS
BLANKING PRESSES
ETC.
METAL WORKING MACHINERY
MINING MACHINERY
MIXERS
MOTOR-GENERATOR SETS
OFFICE APPLIANCES
OIL BURNERS
OVENS
PAINT MAKING MACHINERY
PAPER MAKING MACHINERY
PETROLEUM PRODUCTS MACH'Y
POLISHING MACHINERY
POWER PLANT MACHINERY
POWER TABLES
PRINTING MACHINERY
PULVERIZERS
PUMPS
RECORDING INSTRUMENTS
REFRIGERATING MACHINERY
SCALES
SEPARATORS
SEWING MACHINES
SHOE MAKING MACHINERY
SMELT'G & REFIN'G MACH'Y
SOAP MAKING MACHINERY
STOKERS, MECHANICAL
STONE WORKING MACHINERY
SUGAR REFINING MACHINERY
TABULATING MACHINES
TESTING MACHINES
TEXTILE MACHINERY
TYPEWRITERS
UNIT HEATERS
VACUUM CLEANERS
VENTILATING EQUIPMENT
WASHING MACHINERY
WINCHES
WOODWORKING MACHINERY

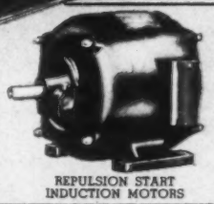

GENERAL PURPOSE SQUIRREL CAGE MOTORS

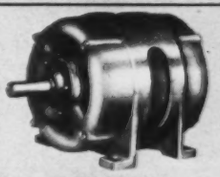
D.C. MOTORS, GENERATORS AND DYNAMOMETERS

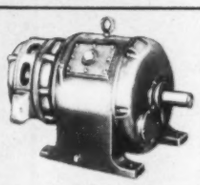

CAPACITOR MOTORS

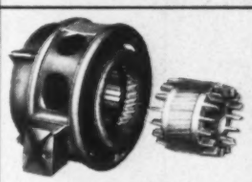
CHEMICAL PLANT MOTORS

A.C./D.C. UNIVERSAL MOTORS

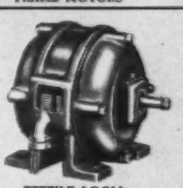

REPULSION START INDUCTION MOTORS

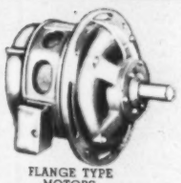

TEXTILE SPINNING FRAME MOTORS


GEAR MOTORS

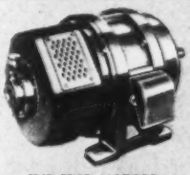

SHAFTLESS MOTORS

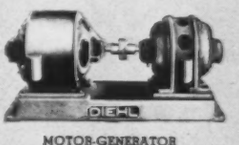
VERTICAL MOTORS—RING BASE


TEXTILE LOOM MOTORS


FLANGE TYPE MOTORS

VERTICAL MOTORS TRIPOD BASE

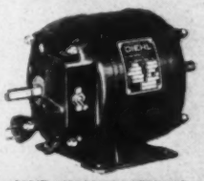

SLIP RING MOTORS



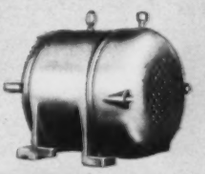
MOTOR-GENERATOR SETS

DIRECT CURRENT MARINE MOTORS AND GENERATORS

D. C. ENGINE TYPE GENERATORS



SPLIT PHASE FRACTIONAL HORSEPOWER MOTORS


TOTALLY ENCLOSED FAN-COOLED MOTORS

Plant and product modernization demand the utmost in motor drive efficiency, economy and dependability. There is only one RIGHT motor to meet the requirements of each application.

The diversified Diehl line offers many types and sizes from which to select the exact motor to fit your needs. Standard motors are obtainable from stock for usual requirements. Special designs for exceptional conditions can be developed in a minimum of time. All are products of the same facilities and abilities which have enabled Diehl to design and produce motors that have satisfactorily met the requirements of exacting manufacturers in all branches of industry for half a century.

Tell us your requirements and our engineering staff will gladly recommend the proper motor equipment to meet your needs.

To all who use or choose motors the Diehl Catalog No. 1881 illustrated above will prove very helpful. Write for a copy.

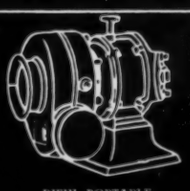
DIEHL MANUFACTURING CO., Elizabethport, N. J.
Pioneer Manufacturers of Motors, Generators and Fans
Electrical Division of THE SINGER MANUFACTURING CO.
ATLANTA BOSTON CHICAGO DALLAS NEW YORK PHILADELPHIA

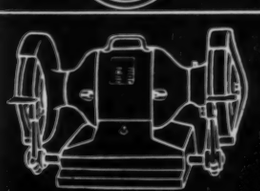
Diehl

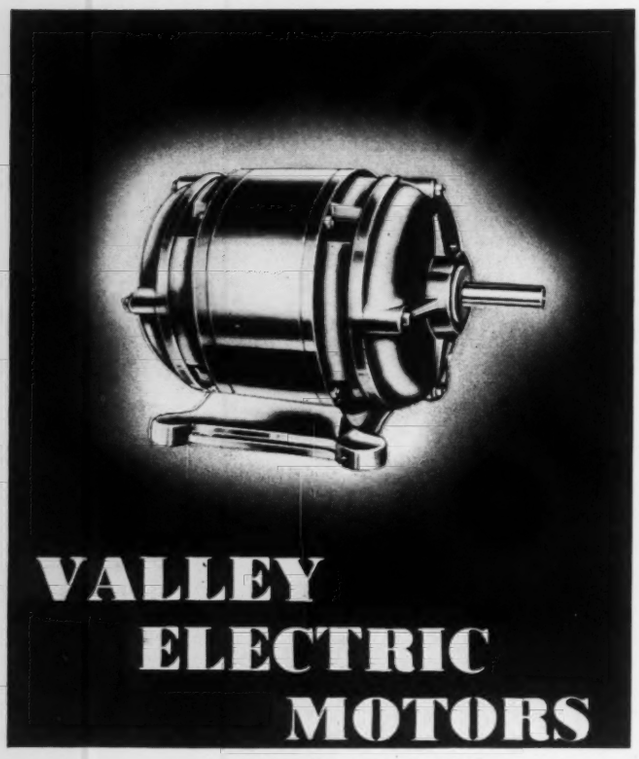
DIEHL DESK AND BRACKET FANS

DIEHL AIR CIRCULATORS

DIEHL EXHAUST AND VENTILATING FANS


DIEHL PORTABLE VENTILATING SETS


DIEHL ELECTRIC GRINDERS



VALLEY ELECTRIC MOTORS

—designers found them superior

With an eye toward that happy combination of economy, efficiency and lasting dependability, prominent designers, everywhere, are selecting Valley Electric Motors. They know that Valley Electric engineers are just as alert to the possibility of improvement as they were twenty years ago when Ball Bearings were incorporated in their designs.

Features which have kept Valley Motors in the spotlight are:

1. NO DEAD SPOTS: The careful design of Valley Ball-Bearing Motors has eliminated occurrence of "dead spots."

2. EFFICIENT AND VENTILATED WINDING: The Valley Short Throw Winding, together with the form-wound coils are used, and result in high efficiency and low heating.

3. 40°C. MAXIMUM TEMPERATURE RISE: Valley Motors are rated 40°C. maximum temperature rise under continuous full load conditions. In actual service, their performance is much better than this rating.

4. SQUIRREL-CAGE WELDED ROTOR: All Valley squirrel-cage rotors are welded by a special preheating process insuring a perfect union of bar and end-ring.

5. BALL BEARINGS: All Valley Motors are equipped with ball bearings especially selected for their suitability for motor applications. These bearings are protected by oil seals, and are absolutely dust-proof.

VALLEY ELECTRIC CORPORATION

4221 FOREST PARK BLVD. • ST. LOUIS

in an outward direction as to sweep away foreign matter and water which might be thrown against the casing.

The identification number for the patent is 2,074,067.

ADVANTAGES inherent in an outboard driving unit have been attained in connection with an inboard motor, in a novel boat propulsion apparatus invented by Robert T. Svendsen of Minneapolis. This mechanism is shown in normal driving position in *Fig.* 2.

The device consists of a strong tubular frame with a bottom fin shaped like a reversed sled runner. This frame is hinged to the stern of the boat and carries the propeller and rudder at its outer end, both being protected below by a skag which is the upturned end of the "sled runner." As shown in the auxiliary end view in the illustration, lateral fins at the outer end of the frame serve as automatic depth adjusting and anti-cavitation means.

The frame carries two shafts, the upper operating the rudder through a universal joint, sliding coupling and bevel gears; and lower being the propeller shaft which is connected to the engine through an intermediate shaft and two universal joints. This short

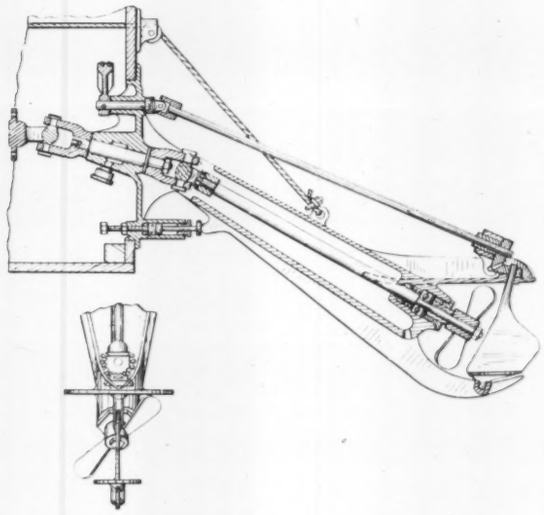
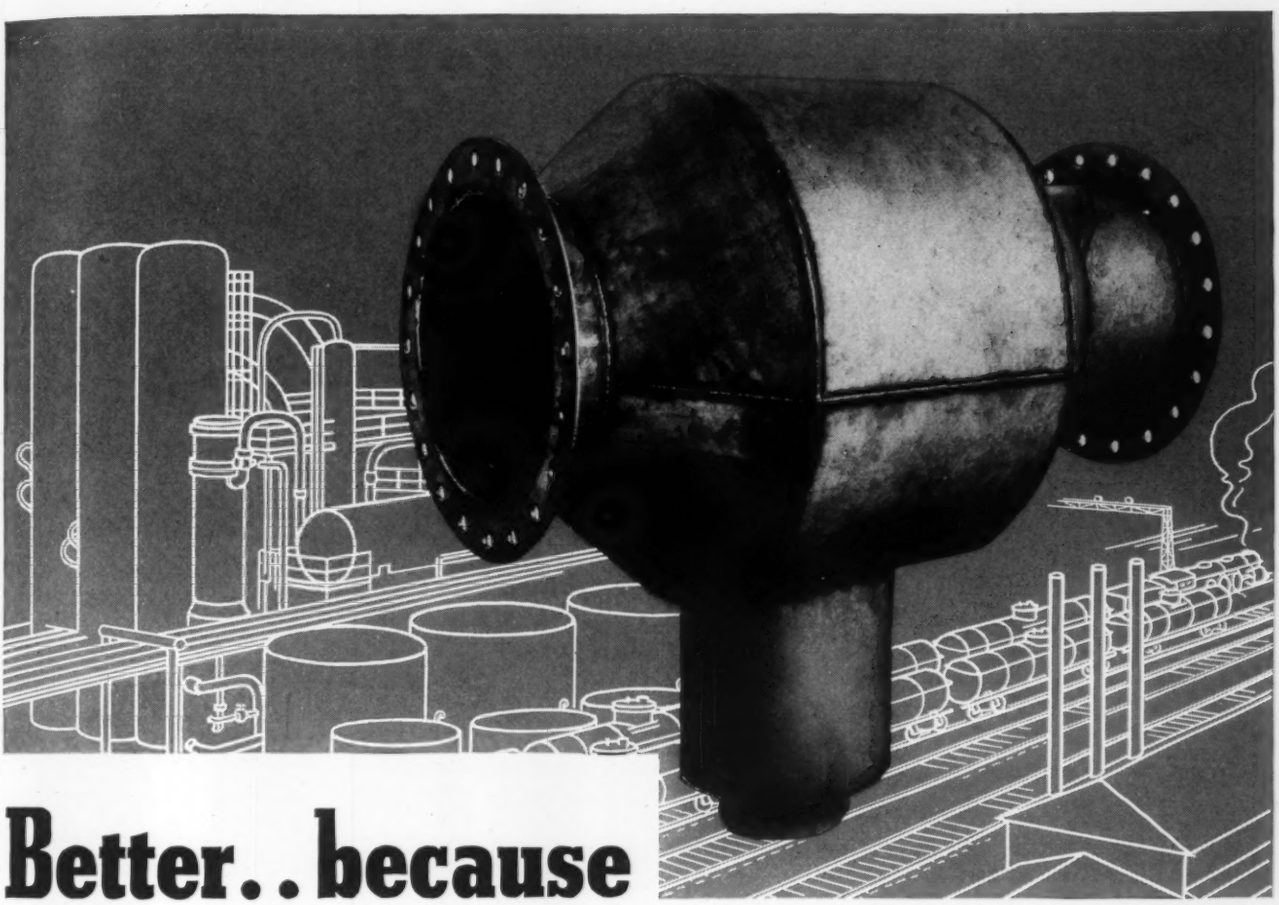


Fig. 2—*Jointed support enables propeller safely to ride over submerged obstacles*

intermediate shaft passes through the stern of the boat above the waterline, which obviates the use of the conventional stuffing box.

Weight of the hinged frame normally keeps the propeller submerged to a depth determined by a spring stop in the stern of the boat. This stop is adjustable from within the hull. However, if the boat passes over a submerged log, rock or other obstruction, the long

(*Continued on Page* 94)



Better..because

it's Chromium Steel

THIS all-welded separator for recovering nitric acid fumes is *better because it's chromium steel!* Eighteen per cent chromium in this steel gives it extra strength, toughness and corrosion resistance so that it resists the attack of nitric acid and other corrosive commercial chemicals even when concurrently exposed to high temperatures. Lower maintenance, longer equipment life and a better, purer product result.

In thousands of other corrosive processing applications, chromium steel does a better job and makes a better product. You should investigate the possibilities of chromium steel in your own plant.

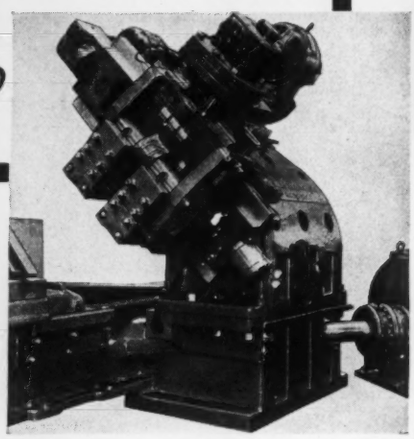
Electromet does not produce iron and steel, but for over thirty years has made the ferro-alloys that go into their production. The practical data thus developed on chromium and other alloy steels and irons and the assistance of Electromet metallurgists are available to aid you in determining what alloy steels and irons are suitable for specific applications. Write for further information.

ELECTRO METALLURGICAL COMPANY
Unit of Union Carbide and Carbon Corporation

UCC

CARBIDE & CARBON BUILDING **Electromet** Ferro-Alloys & Metals 30 EAST 42nd ST., NEW YORK, N. Y.

HOW LONG DO YOU WANT YOUR MACHINES TO *last?*



As long as they continue to produce at a profit of course—but even the most modern machine becomes a liability when it is down for repairs for want of proper lubrication.

Good judgment demands that you protect your customers' investment in the machine equipment you build, through the use of a Farval Centralized System of Lubrication, which will:

—insure full production by eliminating shutdowns from lack of lubrication;
—provide positive delivery of lubricant to every bearing;
—give each bearing the proper amount;
—prolong life of bearings indefinitely;
—add years to the life of machines themselves.

The Farval System is a mechanical method of delivering a clean lubricant from a central station under high pressure to a group of bearings, in exact, measured quantities. Operation is constant and positive, regardless of the number of bearings in the system, *and not a bearing is missed.*

Farval Engineers will gladly help you plan the System best adapted to the machines you design. The Farval Corporation, 3265 East 80th Street, Cleveland, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Manufacturers of Automotive and Industrial Worm Gearing.

FARVAL

CENTRALIZED SYSTEM OF LUBRICATION

Special Delivery to Every Bearing

NEW *Materials and Parts*

Two Pumps in One Housing

DESIGNED especially for arbor presses, clamping fixtures, indexing devices, clutches, brakes and similar applications, a new line of pump units, WX model, is announced by Sundstrand Machine Tool Co., Rockford, Ill. Quick action for the approach and return of a ram or clamping member is provided by a large capacity Sundstrand Rota-Roll pump with a small sized pump of the same type producing the clamping or working pressure. All control valves for the two pumps are contained in one compact housing. This arrangement reduces piping to a minimum and results less heating of oil as only the small pump is operated at high working pressures. Both pumps are mounted on the same shaft and driven at 1200 RPM. An oil reservoir with motor base can be furnished, together with any type of remote pilot valve that is desired.

Piping is reduced to a minimum and a single shaft drives two pumps in this combination unit

New Steels Easily Machined

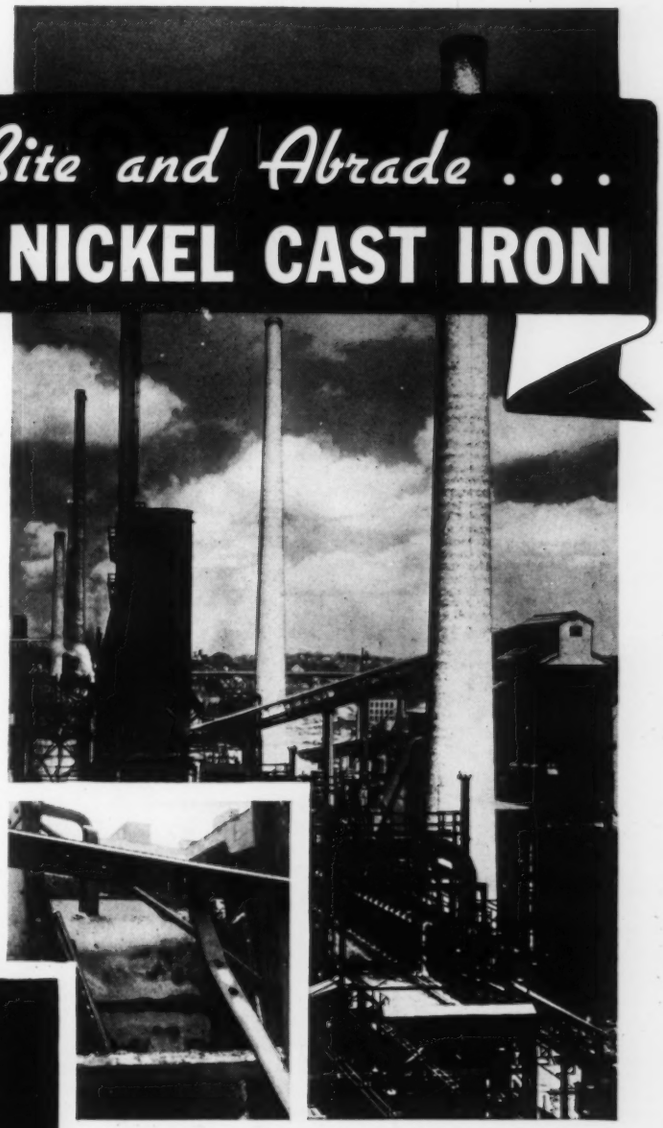
THREE high-carbon steels, all machinable at over 150 feet per minute, yet ductile enough to be easily bent have been developed by the Monarch Steel Co., Indianapolis, Ind. Speed Case X-1515 will machine at over 200 surface feet per minute and is used in many applications where the ability to stand severe cold forming, crimping, rolling or bending operations is essential. More strength than Speed Case X-1515 and almost as good machinability are claimed

(*Continued on Page* 70)

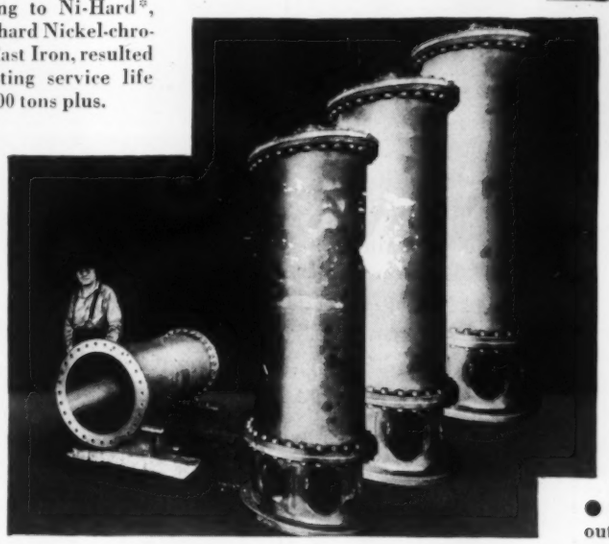
Where substances Bite and Abrade . . .
ECONOMY *dictates* NICKEL CAST IRON

INDUSTRY'S search for more enduring metals is inevitably leading to more widespread use of the alloys containing Nickel. For by fortifying the simple irons and steels with additions of Nickel, materials are being produced that offer stiff opposition to metals' deadliest foes—wear, corrosion, stress, shock, heat, etc. Pictured here are several examples where the use of Nickel alloys have substantially increased the life of equipment and resulted in marked economies.

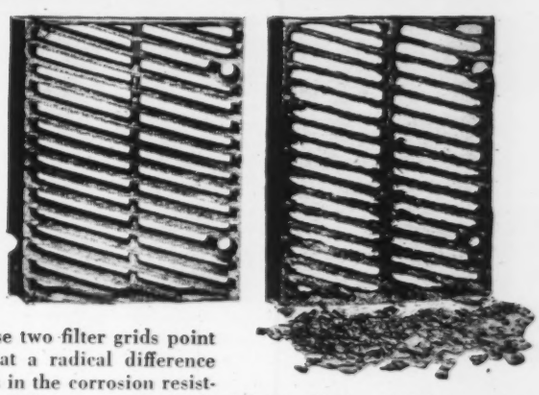
☼ ☼ ☼



● Every year the Rochester Gas & Electric Company handles thousands of tons of coke. The chutes and slides through which it flows are subjected to incessant abrasion. Tripper plates (see inset at right) were formerly made of both grey iron and special steel, with maximum life of 33,500 tons and 18,000 tons respectively. Switching to Ni-Hard*, a super-hard Nickel-chromium Cast Iron, resulted in boosting service life to 250,000 tons plus.



● If cylinders are to prove economical in service they must not only be wear resistant but unusually strong. Those pictured above were designed for use at a California reservoir. They operate under high oil pressure and the specifications called for a tensile strength of 50,000 p.s.i. By using Ni-Tensyliron*, a high strength cast iron composition containing Nickel, tensile strength was stepped higher than the specifications—to 60,000-80,000 p.s.i. with a Brinell hardness of 265-285.

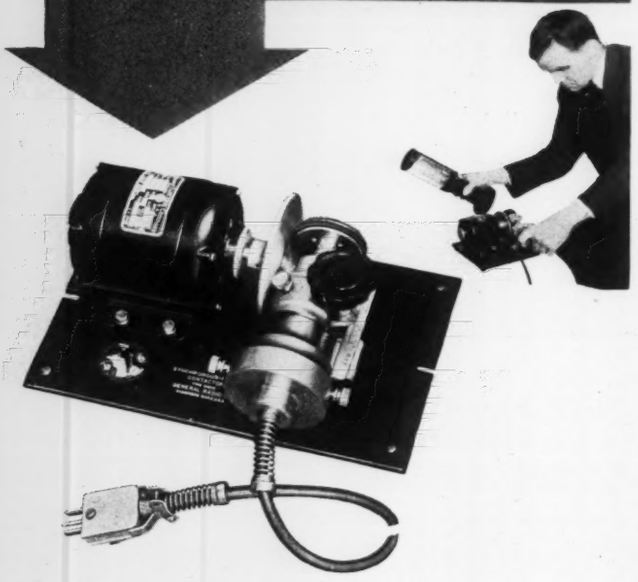


● These two filter grids point out what a radical difference there is in the corrosion resistance of different metals. At the left is a filter grid from a rotary salt drier. It is made of Ni-Resist*, a special cast iron containing Nickel, copper and chromium. At the right, a grid of plain cast iron has seen the same type of service in the same plant. The former was 18 months old when this picture was taken, and after 5 years is still in service; the latter was 4 months old when photographed before scrapping. The Nickel Cast Irons can effect similar economies in *your* plant. We invite consultation on their use in your equipment.

*Reg. U. S. Pat. Off. by The International Nickel Co., Inc. Canadian Patents Nos. 281,986; 324,552; 278,180.

THE INTERNATIONAL NICKEL COMPANY, INC., NEW YORK, N.Y.

GENERAL RADIO
selected
BODINE MOTORS



for their
STROBOSCOPE FLASHERS

Io industrial and radio engineers everywhere, the name "General Radio" on equipment is a guarantee of the highest quality. And when General Radio needed fractional horsepower motors to drive their stroboscope flashers, they chose Bodine motors as the very finest obtainable.

Bodine motors are built just as well as Bodine can build them. Only the finest materials are used. Experienced craftsmen, not production line piece workers, assemble Bodine motors. Units are carefully tested at every step in the production process. Bodine motors are quiet, smooth running, efficient, long lived, and trouble-free. All types from 1/500 hp to 1/6 hp. Send us complete data on your machine for motor recommendations. Bodine Electric Co., 2258 W. Ohio St., Chicago, Ill.

BODINE
FRACTIONAL H. P.
MOTORS
ENGINEERED FOR YOUR PRODUCT

Materials and Parts

(*Continued from Page* 66)

for Speed Treat X-1535 which contains .30 to .40 per cent carbon. It has a tensile strength of approximately 95,000 pounds per square inch, will machine at over 150 feet a minute and gives good tool life. The most recent development has been Speed Treat X-1545, containing .40 to .50 per cent carbon, which has a tensile strength of 110,000 pounds per square inch and like the other two steels has good machining properties.

Reducing-Valve Corrosion Resistant

SUITED for oil as well as water and air, an improved type E high pressure reducing valve has been announced by Atlas Valve Co., 282 South street, Newark, N. J. Internal metal parts of the valve are entirely stainless steel. A formed packing of special material, superior to leather, has been adopted which is immune to oil and other fluids commonly used in hydraulic machinery. Pressure on the seat is balanced by a piston with the result that variations in high initial pressure have little effect on the reduced pressure.

Stainless steel is used for internal parts of valve, insuring long life and trouble-free service

Motor Starter Has "Ruptors"

AN ACROSS-THE-LINE, air motor-starter, equipped with "ruptors," known as type AP-7 has been placed on the market by Allis-Chalmers Mfg. Co., Condit Works, Boston, Mass. The "ruptors" are enclosing chambers which confine and depotentiate the arc formed by circuit interruption. These "arc-depotentiating chambers" greatly increase the interrupting ability of the contacts, and form an isolating barrier between contacts of opposite polarity. Other features of the motor-starter include: Enclosed temperature overload relays; large silver

A POSITIVE, *quiet, flexible drive for fractional H. P. units*

LINK-BELT 3/16" SILENT CHAIN

Five gallon ice cream freezer manufactured by Mills Novelty Co. Driven by a 3/16" pitch x 1½" wide Link-Belt Silverstreak silent chain drive at a 10 to 1 reduction on 16-5/8" centers, employing 23 and 230 tooth wheels. This drive operates the freezer paddle shaft at 175 R.P.M. direct from a 1750 R.P.M. one H.P. motor. Housing removed to show chain.

● Machine designers, and machinery users have found "industry's biggest little silent chain drive"—using a 3/16" pitch Link-Belt Silverstreak silent chain — the ideal solution of problems calling for a positive, quiet, flexible drive for fractional horsepower units.

It is the smallest chain drive made, employing links of only 3/16" pitch and compares with the Link-Belt Silverstreak silent chain drive which for more than 30 years has held the enviable reputation of combining flexibility, durability and efficiency in the transmission of power in horsepowers up to 1000 and over.

This chain is made in three types — middle guide, side flanged, and duplex. The middle guide and side flanged chains are employed where all shafts are driven in one direction, and the duplex where reverse direction is desired on some shaft or shafts, or where adjustment features are required.

If you have a troublesome belt or gear drive, or desire assistance on a new design, submit full details to our nearest office or direct to Link-Belt Company, 519 N. Holmes Avenue, Indianapolis, Ind.

5896

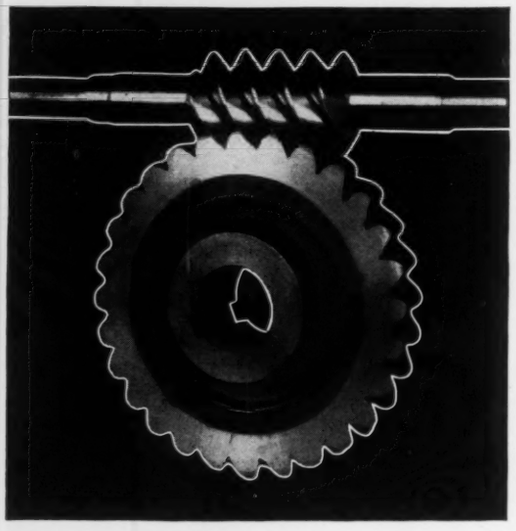
LINK-BELT POSITIVE DRIVES INCLUDE

ALL TYPES OF

GEARS

Cut Spur, Straight and Spiral Bevel, Mitre, Spiral, Worm, Internal, Helical and Herringbone Gears, in all sizes and of all materials, Sprocket Wheels, Racks, Flexible and Universal Couplings

ALSO ALL TYPES OF SPEED REDUCING TRANSMISSIONS



Almost a half century of making all types of cut gears for every conceivable purpose has proved the D.O. James service a valuable one. Speedy production without sacrificing D. O. James manufacturing perfection assures you of quality gears ***when you need them.*** We offer you the accumulated experience, skill and knowledge of fifty years of successful gear making. Let us help you with your next requirements.

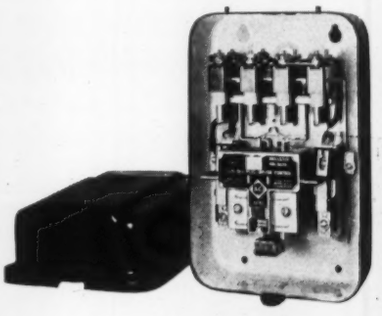
WRITE FOR CATALOGS AND BULLETINS

D. O. JAMES MANUFACTURING CO.

Established 1888

1120 West Monroe Street • Chicago, Illinois

double break contacts; pole units consisting of individual molded bases mounted on a steel chassis, and

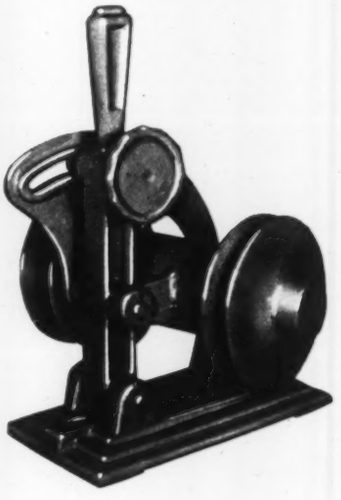


Enclosing chambers confine and depotentiate arc formed by circuit interruption in this motor-starter

vertical make and break contacts insuring silent operation. The starter is furnished for 7½ horsepower at 440 and 550 volts; 5 horsepower at 220 volts and 3 horsepower at 110 volts.

Few Parts in Variable Speed Unit

SPEED control may be easily obtained with a simple variable speed drive placed on the market by Columbia Vari-speed Co., Wheaton, Ill. Known as the Hi-eff, the unit incorporates the adjustable V-pulley principle in a single shaft design. A five to



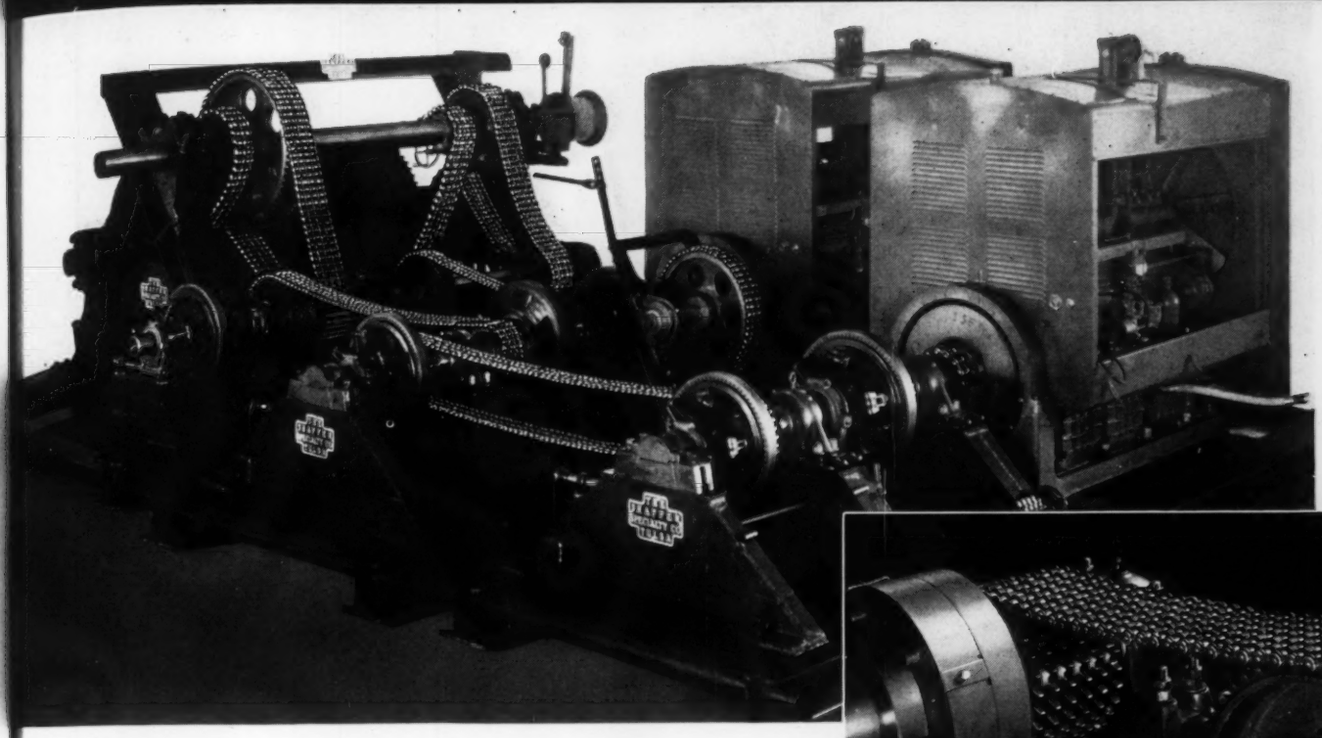
Adjustable V-pulley enables this unit to have a speed ratio of five to one

one speed ratio is possible, and tests are said to show the drive to be over 90 per cent efficient. The single shaft is mounted on ball bearings, insuring efficiency and easy lubrication. The unit is offered in sizes from ¼ to 7½ horsepower.

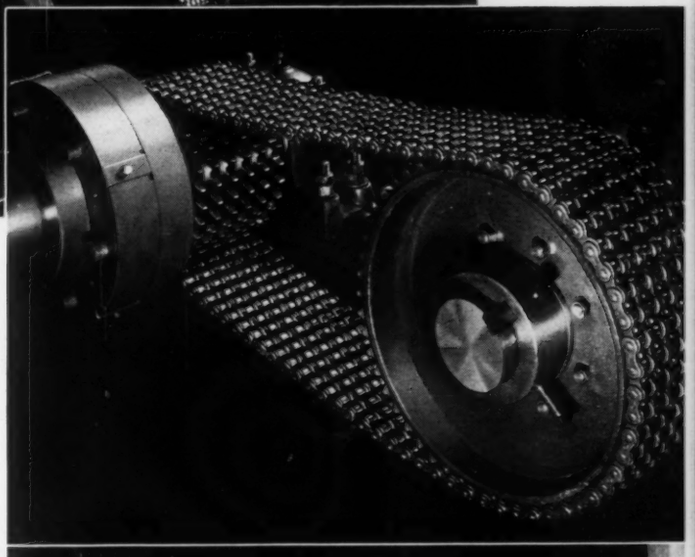
Magnetic Controller Developed

A NEW alternating current, multipole, magnetic contactor (type CR2810) has been developed by General Electric Co., Schenectady, N. Y., for controlling small single-phase and polyphase motors. It

FOR THE HEAVY-WEIGHT JOBS, TOO



Oil country machinery drives must be rugged, — and Diamond Roller Chain, because of its reserve strength has come into extensive use. The Shaffer Drilling Rig is a good example of Diamond-Driven machinery.

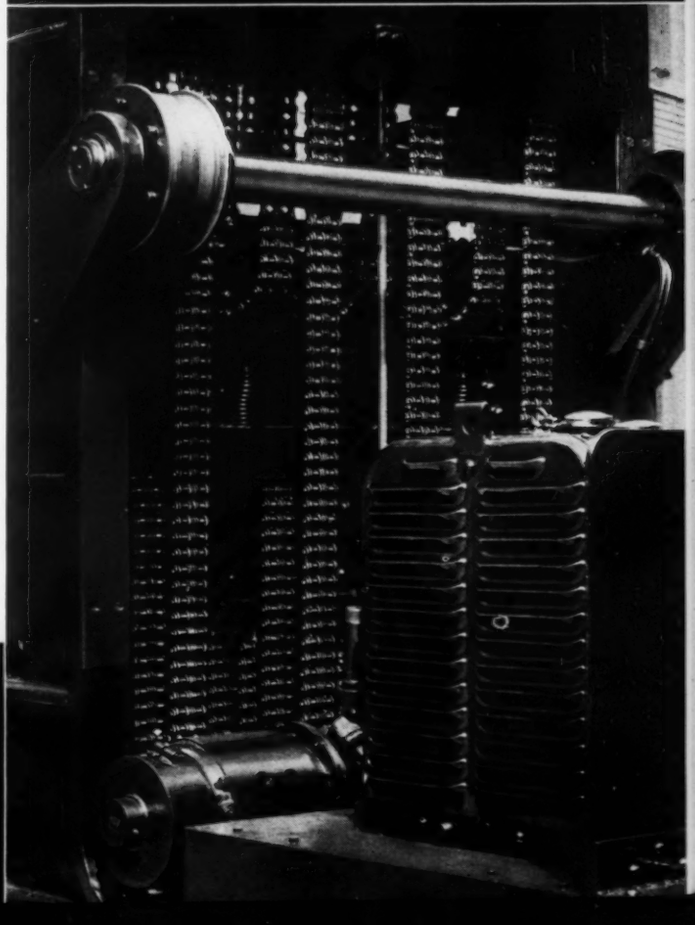


200 h.p., 725 R.P.M. motor to compressor drive — sextuple strand Diamond Roller Chain. This replaced another type of transmission.

● For 30-ton lift trucks, oil field machinery, big compressors, giant excavating machinery—where brute strength and reserve capacity are essential Diamond Roller Chain has established remarkable performance records.

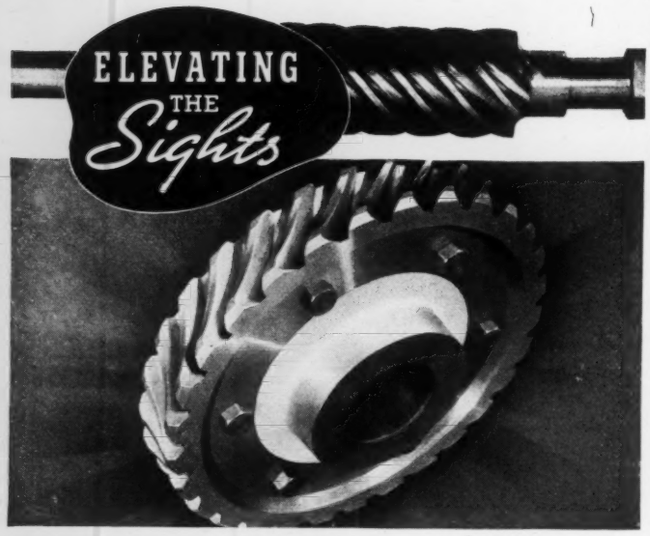
In many cases where Diamond Chains replaced other power transmissions comparative records have shown the unusual endurance and maintained high efficiency.

And in Diamond Roller Chain you get more capacity per width than in any other transmission. . . . Let Diamond prove itself on your toughest jobs. DIAMOND CHAIN & MFG. CO., 435 Kentucky Ave., Indianapolis, Ind. *Offices and Distributors in Principal Cities.*



For handling 30-ton dies this "largest capacity" Automatic elevating-platform truck lifts enormous loads by means of massive double-strand 1¼" pitch Diamond Roller Chains. Motive power also by means of Diamond Chain.

DIAMOND ROLLER CHAIN



THE higher the sights, the farther the travel —whether of projectiles or of business plans reaching far into the future.

This Company has been privileged through the past 25 years, to work with Design Engineers of many large machinery builders — whose "sights" were also high — in adapting Cleveland Worm Gear Drives into various new and original but trustworthy types of speed reduction. Thousands of worm gear units, both standard and special, have been installed in new machinery as the result of this fine Engineering co-operation.

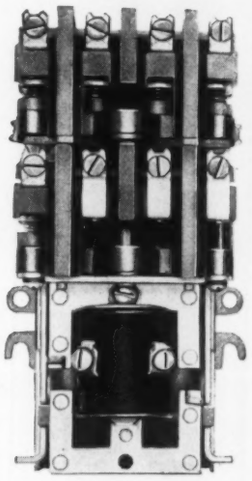
The Cleveland Worm & Gear Company builds Worm Gear Reduction Units for use on equipment of major industries. Design is modern but conservative, production facilities are exceptionally well-planned, testing methods are of the newest. "Clevelands" operate for 10, 15 or more years without requiring any attention whatever.

District Representatives will consult with your own Engineers whenever convenient for you. The Cleveland Worm & Gear Company, 3275 East 80th Street, Cleveland, Ohio.

Affiliate: The Farval Corporation, Cleveland, Manufacturers of Centralized Systems of Lubrication.

CLEVELAND *Worm Gear Drives*

may also be used as a flexible relaying device for comprehensive control systems such as are used on machine tools. The new contactor is compact and easily installed. It can also be furnished as a magnetic switch mounted in a small sheet-metal case which is suitable for general applications under normal atmospheric conditions. The device, used either as a



Multipole relay may be used as magnetic contactor or switch

contactor or a magnetic switch, has a maximum rating of 10 amperes at 600 volts. Fine silver contacts, of the double break type, are used to minimize arcing and to increase the interrupting capacity, thus enabling the contactor to withstand severe service. Flash-overs between the poles are practically prevented by large, hot-molded arc barriers.

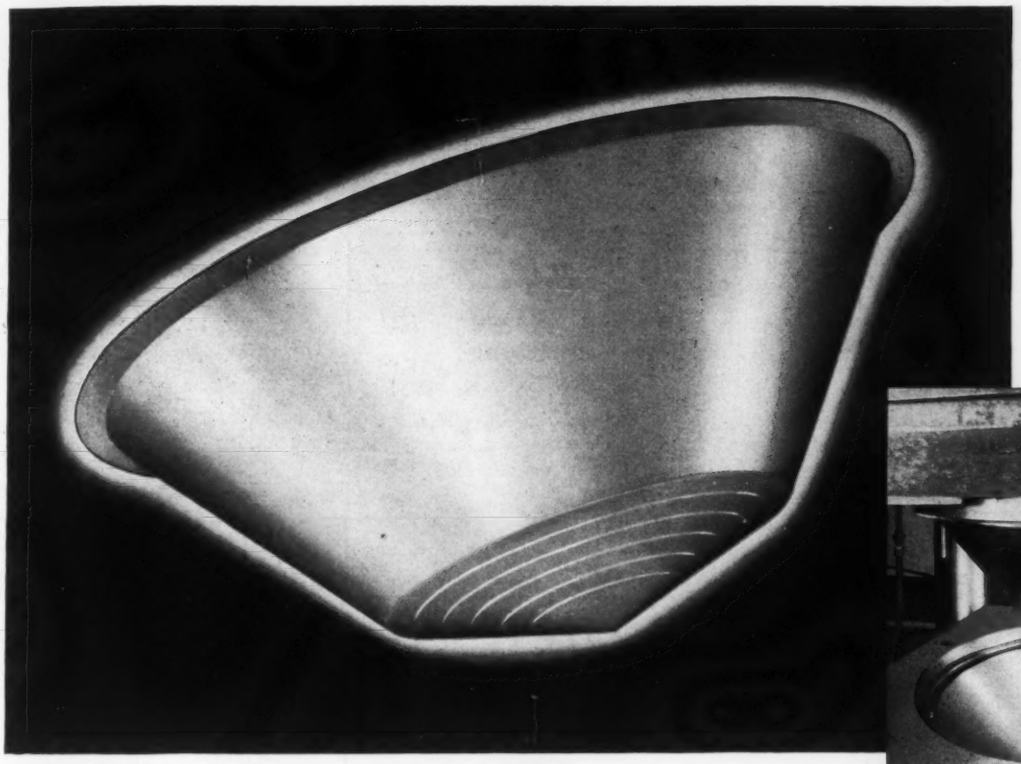
Oil and Gas-Proof Gasket Developed

INCREASED resistance to oil and gases such as freon, methyl chloride and sulphur dioxide is obtained in a new compressed asbestos, sheet packing known as Prenite 20-M and developed by B. F. Goodrich Co., Akron, O. Absence of sulphur in its composition makes it less apt to corrode metal parts than other sealing gaskets. Prenite 20-M sheet packing is available in 50 by 50-inch sheets in 1/16, 1/32 and 1/64-inch thicknesses.

D.C. Motors Have Special Uses

WEIGHT has been reduced to a minimum in two types of special direct current motors recently introduced by Electric Specialty Co., Stamford, Conn. One is designed for operating the wing flaps and the other for raising the landing gear of an airplane, but are suited for any applications where light weight, compactness, high efficiency and reliability are requisites. The motors operate from storage batteries and because of the comparatively low input current and short time of operation, they cause a minimum

TO MOLD THE LARGEST PIECE EVER MOLDED . . .



WAKEFIELD BRASS CO. USES G-E LARGE-UNIT MOLDING FACILITIES

The famous housings for the Toledo Scale and the Western Union Printer must now give up their position in the spotlight of plastic achievements to the new twenty-six and one-half-inch light reflector molded by General Electric for the Wakefield Brass Company.

In square-inch area, the Wakefield Reflector is over twice the size of the scale housing and over three times the size of the printer casing. It is the largest piece ever molded.

General Electric is justly proud of this new large-unit molding development. To you who have not seriously considered the use of these facilities for large molded housings, we suggest your investigation from the standpoint of reducing costs, simplifying assembly, assuring fine permanent finish, and increasing sales.

Find out what G-E large-unit molding can do for you. Contact a plastics specialist in the nearest G-E office — New York, Cleveland, Detroit, Chicago, Lynn, Mass., and Meriden, Conn. — or write Section P-106, Appliance and Merchandise Department, General Electric Company, Bridgeport, Connecticut.

GENERAL ELECTRIC

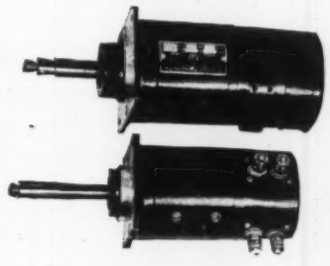
Plastics

APPLIANCE AND MERCHANDISE DEPARTMENT, GENERAL ELECTRIC COMPANY, BRIDGEPORT, CONNECTICUT

and you'll land
the SPRING
RAYMOND SPRINGS
RAYMOND MFG. CO.
DIVISION OF ASSOCIATED SPRING CORPORATION
280 So. Centre St. - - - CORRY, PA.

THE SOLID SHIM
THAT P-E-E-L-S
FOR ADJUSTMENT
LAMINUM
Precision adjustment SHIMS
anti-friction bearings
LAMINUM SHIMS are an invaluable "first aid" on anti-friction bearing applications. Precision adjustments of .002" or more at a time are made by simply P-E-E-L-I-N-G the laminated shim! No filing . . . no machining. The same saving of precision machining in factory assembly is repeated for the user every time re-assemblies are made!
LAMINATED SHIM CO., INC., 21-26 44th Ave., Long Island City, N. Y.
Cleveland Detroit Milwaukee

drain on the battery. Commutators of the motors have been designed with a comparatively large number of segments; brushes are of a special composition to reduce commutator wear and obviate brush

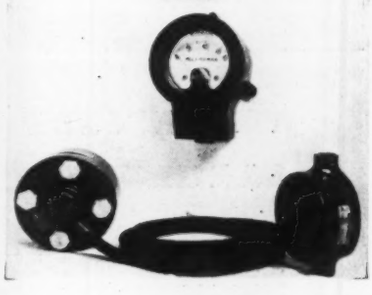


Brushes of special composition reduce wear in these motors used on airplanes

replacement. The landing-gear motor weighs 14¾ pounds, the unit for operating the wing flaps weighs 10½ pounds.

Electric Speedometer Announced

SUITED for use on vehicles where the distance from wheels to driver is too far for a flexible cable, an electric speedometer has been introduced by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.



Speedometer unit consists of generator for mounting on wheels of vehicle, wires, and recording instrument

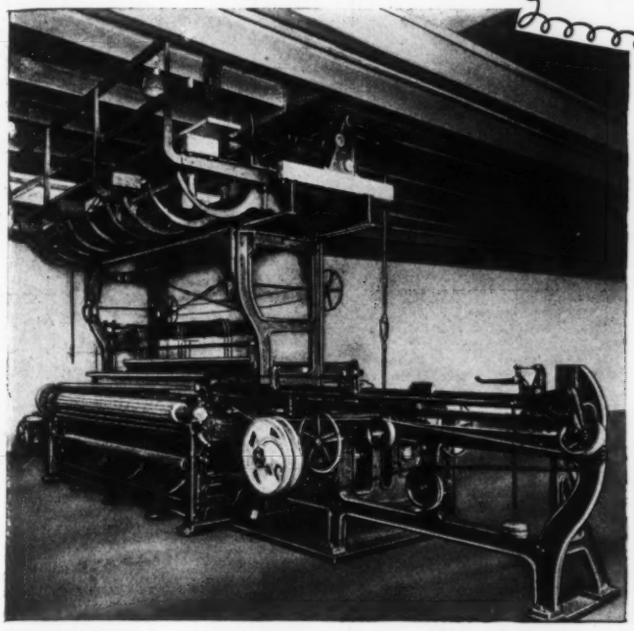
The speedometer consists of a simple alternating current generator suitable for mounting near the wheels and wires leading to the indicating instrument. The unit is designed particularly for use on steam, diesel or electric locomotives. The instrument in the cab is calibrated in miles per hour and has extra large jewels and pivots which will withstand severe vibration.

Start-and-Stop Controller

AUTOMATIC start-and-stop control can now be obtained without additional equipment on motor-driven, single-horizontal air compressors by the use of a magnetic unloader introduced by Worthington Pump and Machinery Corp., Harrison, N. J. The unloader operates on standard electric equipment and can be installed wherever a conventional automatic

(*Continued on Page* 80)

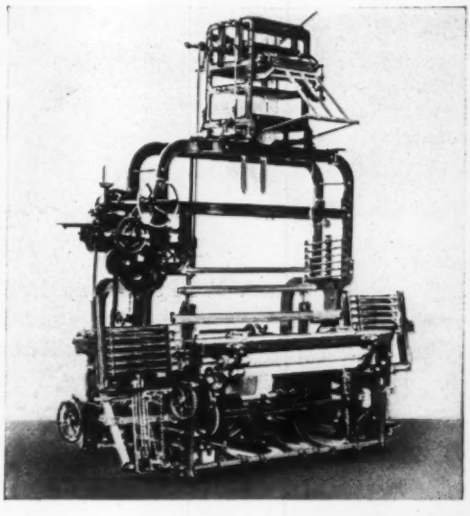
CARPETS-RUGS and ROLLER CHAIN



Many a room owes its charm to the glowing colors of Bigelow-Sanford carpets and rugs. They, in turn, depend in part on Baldwin-Duckworth chain as used in improved loom equipment, for their popularity and beauty.

Baldwin-Duckworth installations help make profits not only in textile machinery, but in all industrial applications where dependable, economical power transmission, elevating or conveying is required. Our catalog lists all standard chains, sprockets and contains valuable technical information. Send for a copy. Baldwin-Duckworth Chain Corporation, Springfield, Mass.

Shown above is a modern Crompton & Knowles Wilton Loom made for the Bigelow-Sanford Carpet Co., Inc. Its equipment includes Baldwin-Duckworth chain.



It is a far cry from this 1888 model loom to the highly efficient equipment in use today by Bigelow-Sanford.

Here again you find Baldwin-Duckworth chain associated in the production of a nationally known product.

FOR FURTHER INFORMATION
SEE OUR CATALOG IN SWEET'S

BALDWIN DUCKWORTH

SPRING WASHERS

Spring washers and lock washers of every type and size, including the well-known Hipower and Kantlink types. There are thousands of more places where spring washers would improve the value of any product where bolts, nuts, cap or machine screws are used.

STEEL ROD ENDS

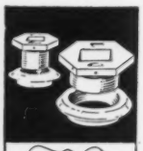
Drop forgings including steel rod ends of the adjustable yoke, plain yoke, and eye types. These articles in standard sizes and threads afford tremendous savings over special designs.

RETAINING RINGS

Spring retaining rings of special heat-treated spring steel are carried in many stock sizes—both open and closed types. Use of a spring retaining ring is an excellent manner of creating a shoulder on a shaft.

STEEL BARREL CLOSURES

Forged and machined fittings for steel barrels, drums, tanks and metal packages, including plugs, rings and flanges. Very rugged for use in transportation of alcohol, turpentine, oils and other expensive liquids.



CONTAINER HANDLES

Forged steel handles for heavy containers—can be rigidly welded, riveted or attached by a strap to lie flat when not in use. Rugged and most satisfactory for hard usage.

RHEOSTATS–RESISTORS–LOAD BOXES AND SPECIAL APPARATUS

Our electrical division—Hardwick, Hindle, Inc.—makes as fine electrical resistance products, fixed and variable, as can be devised.

• • • • • •

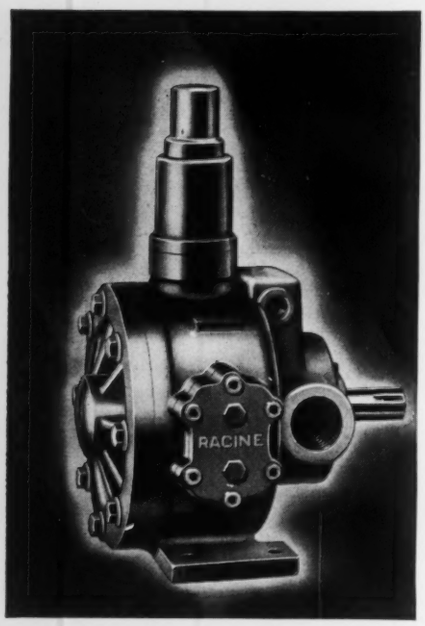
Other products include windows for buses and railway cars, railway car window curtains, curtain rollers and fixtures, sash locks and lifts.

THE NATIONAL LOCK WASHER COMPANY

NEWARK, N. J. — EXPORT DIV., 15 E. 26 St., N. Y. C.

RACINE

Variable Volume Hydraulic Pump



A thoroughly proven, efficient pump for power transmission.

Capacities—
0 to 2000
0 to 4000
0 to 6000
cu. in. per min.

The variable volume feature eliminates bypassing of surplus oil, decreases heating and reduces horse-power requirements. Rated for pressures up to 1000 pounds per square inch.

Successfully applied and proven highly satisfactory on such applications as:

Presses
Die Casting Machines
Welding Machines
Chucking Operations
Machine Tools
Table Movements
Stokers
Conveyors
Broaching Machines
Bending and Rolling Equipment, etc.

A variety of valves and controls are available for standard operations

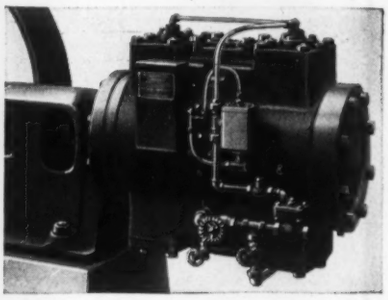
RACINE TOOL & MACHINE CO.

1773 State St. Racine, Wis.

Materials and Parts

(*Continued from Page* 76)

starter is used for controlling the compressor motor. If connected to the motor starter, the compressor

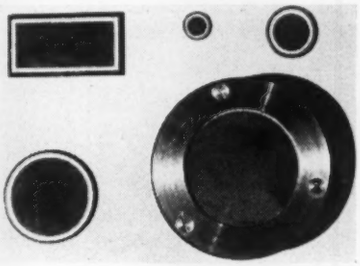


Automatic unloader is easily installed and operates on standard electric equipment

starts and stops on the demand for air. When connected to the magnetic unloader, the compressor runs continuously and simply loads or unloads depending upon the need for air.

Photoelectric Cells Introduced

PHOTOELECTRIC cells of increased power and sensitivity are available under the tradename "Electrocell" through Dr. F. Lowenberg, 10 East 40th St., New York. The elements are sold either mounted in a Bakelite holder or unmounted. In the latter state they resemble plain coin-like disks in contrast



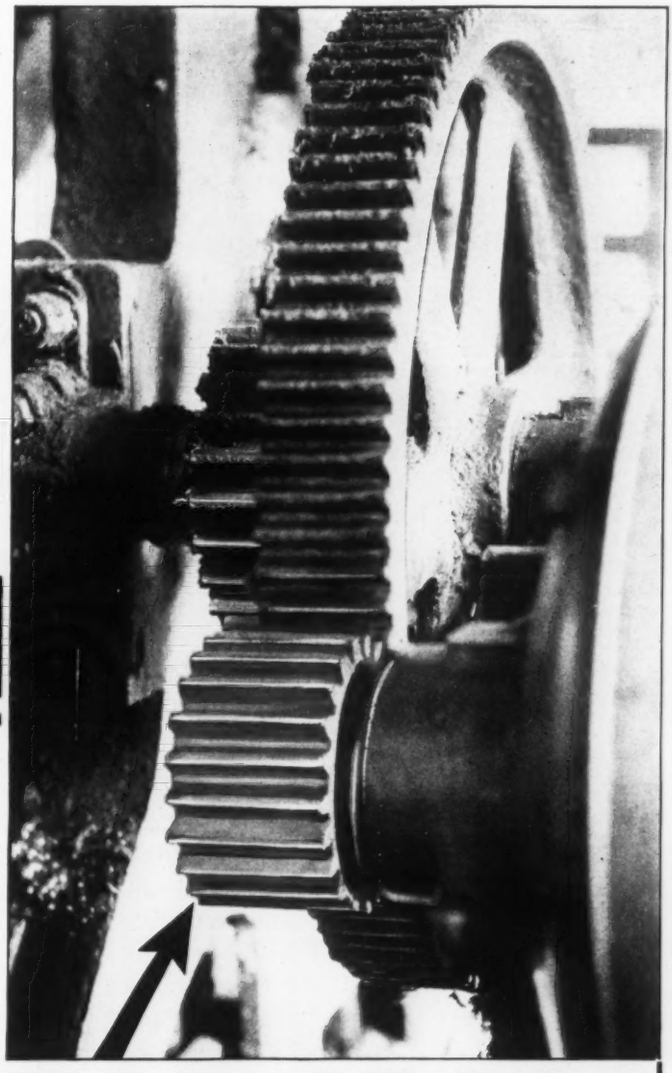
Cells produce enough electricity within themselves when subjected to light beam to energize solenoids

to the gas or vacuum filled tubes used in the conventional photoelectric cell. Their principal application is for the measurement of light valves and transparencies, but they are suitable for such uses as opening doors, counting devices, safety devices and similar applications. The maximum voltage created by "Electrocell" elements is 0.6 volts and the maximum current output 20 milliamperes. The cells are made in Germany.

Motor Types Resiliently Mounted

MOTORS of the repulsion-start-induction, split-phase, capacitor and polyphase types are now available with annular resilient mountings, the Wagner

Give the TOUGH JOBS to FORMICA GEARS



FORMICA gears are quiet and smooth and stand up under some very hard jobs. They are used on grinders, shears, punch presses, printing presses and equipment of all types, both heavy and light. Because they banish noise they make machinery easier to sell. For the same reason they are popular with maintenance and production men whose job it is to keep machinery running smoothly and get out the work with the least wear and tear on men and machines.

THE FORMICA INSULATION COMPANY
4640 Spring Grove Avenue • Cincinnati, Ohio

FORMICA

FORMICA GEAR CUTTERS

The Akron Gear & En'g Co.
Akron, Ohio

Farrel-Birmingham Co.
Inc., Buffalo, N. Y.

Slaysman & Company
Baltimore, Md.

The Union Gear & Mch. Co.
Boston, Mass.

Chicago Rawhide Mfg. Co.
Chicago, Ill.

Perfection Gear Company
Chicago, Ill.

Gear Specialties, Inc.
Chicago, Ill.

Merkle-Korff Gear Co.
Chicago, Ill.

Chicago Gear Works
Chicago, Ill.

Foote Gear Works
Cicero, Ill.

The Cincinnati Gear Co.
Cincinnati, O.

Clarksville Foundry & Machine Co.
Clarksville, Tenn.

The Horsburgh & Scott Co.
Cleveland, O.

The Stahl Gear & Machine Co.
Cleveland, O.

The Master Electric Co.
Dayton, O.

The Adams Company
Dubuque, Ia.

Hartford Special Mchny. Co.
Hartford, Conn.

Beaty Machine Works
Keokuk, Ia.

The Generating Gear Co.
Milwaukee, Wis.

Badger State Gear Co.
Milwaukee, Wis.

Precision Machine Co.
Milwaukee, Wis.

E. A. Pynch Co.
Minneapolis, Minn.

Joaquin Alemany Lopez
Havana, Cuba

New Jersey Gear & Mfg. Co.
Newark, N. J.

Prager, Inc.
New Orleans, La.

J. Morrison Gilmour
New York City

Sier-Bath, Inc.
New York City, N. Y.

Mid-State Electrical Engineering Co., Osceola Mills, Pa.

E. M. Smith Machine Co.
Peoria, Ill.

The Eagle Gear & Mch. Co.
Philadelphia, Pa.

Rodney Davis and Sons
Philadelphia, Pa.

The Pittsburgh Machine & Supply Co., Pittsburgh, Pa.

Perkins Machine & Gear Co.
Springfield, Mass.

Winfield H. Smith, Inc.
Springville, N. Y.

Alling Lander Company
Sodus, N. Y.

Charles E. Crofoot Gear Corp'n.
South Easton, Mass.

Arlington Machine Co.
St. Paul, Minn.

Farwell Mfg. Co.
Toledo, Ohio

Diefendorf Gear Corp.
Syracuse, N. Y.

Worcester Gear Works
Worcester, Mass.

Massachusetts Gear & Tool Co.,
Woburn, Mass.

DOING A GIANT JOB

CHOSEN FOR DEPENDABILITY

This vertical helical SPEED reducer—one of 32 installed in 126 foot tanks to drive 4 large sweep paddles. Ratio 80½ to 1—½ h.p. motor, 1150 r.p.m.

SPUR, WORM, HELICAL, HERRINGBONE, BEVEL GEAR SPEED REDUCTION UNITS

in all types and sizes comprise the Brad Foote line of Speed Reducers now doing continuous, dependable service in plants in various lines. There is a type to fit your needs—Foote engineers will advise you—get the Free 128 page data book.

FOOTE GEAR WORKS, INC.

1301 G. S. Cicero Ave. Cicero, Illinois

A reproduction of Model AC4, 4 Cyl. Air-cooled engine.

8 to 16 H. P.
1200 to 2600 R.P.M.

SAFEGUARD YOUR EQUIPMENT WITH WISCONSIN AIR-COOLED ENGINES

They will protect it against trouble—in any climate—at any season of the year. *Write for details.*

HEAVY DUTY AIR COOLED ENGINES by WISCONSIN MOTOR CORPORATION

WISCONSIN MOTOR CORP., MILWAUKEE, WIS.

Electric Corp., 6467 Plymouth avenue, St. Louis, Mo., has announced. The rubber mounted supports absorb vibration as close to the shaft center as possible. The motor base is made of rolled sheet steel and the rings of rubber are vulcanized to inner and outer steel rings on the base. Latches and nuts lock

Rubber is vulcanized to rings on motor base providing a cushion support for motor

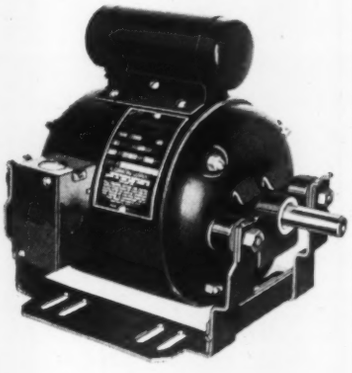
the motor in place in the cradle arms. Belt-tightener bases may be supplied with the motors to meet the requirements of refrigerators and other small, belt-driven appliances.

Lacquer Is Heat Resisting

PARTS and products subjected to temperatures up to 300 degrees Fahr. may be finished in a clear and pigmented air-drying, heat-resisting lacquer developed by Maas & Waldstein Co., Graybar Bldg., New York. The new finish, known as Durheat lacquer, retains its flexibility, color, and adhesion indefinitely at temperatures up to 300 degrees Fahr. The lacquer is supplied in all colors and may be applied by dipping or spraying. It may be applied directly to any metal except aluminum, which must first be covered with a baked coat of Chroprime.

Motor Draws Low Starting Current

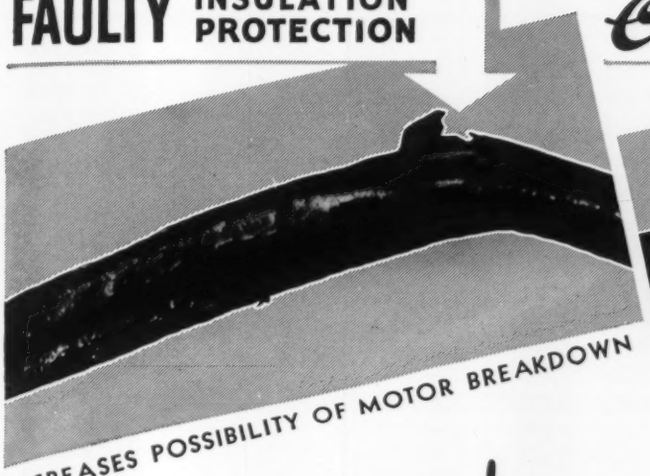
NORMAL starting torque with low starting current is a feature of the new motor announced by the Peerless Electric Co., Warren, O. The motor



Fractional horsepower motor draws little current but has normal starting torque

is a two-speed, capacitor start, induction run motor, resiliently mounted, and supplied in ratings from one-

FAULTY INSULATION PROTECTION



INCREASES POSSIBILITY OF MOTOR BREAKDOWN

Century SPECIAL INSULATION

IS GOOD MOTOR INSURANCE

Special PROTECTION to MOTORS in ABNORMAL SURROUNDINGS

Special **INSULATIONS for**

MOISTURE
STEAM
WATER VAPOR
CORROSIVES
ACIDS (Organic and inorganic) such as hydrochloric, sulphuric, lactic
ALKALIES
dyes and mordants—acid, alkali or neutral
PEROXIDE
FATTY ACIDS
ABRASIVE DUST
METALLIC DUSTS
and many similar destructive agencies

The insulation materials used in Century General Purpose Motors make the windings highly resistant to moisture, mild acids, alkalis, oils, dust, etc. But—to meet the requirements of industries for motors to be installed where abnormal conditions prevail, special insulation treatments are available.

Remember! It is not only the insulation compounds—it's the methods of application and curing that count—methods that have been developed by Century, based on more than 33 years' experience!

At the left are listed only a few of the applications for which Century furnishes Special Insulations . . . What is your problem? Century has the answer!

Century MOTORS

CENTURY ELECTRIC COMPANY
1806 Pine Street • • • St. Louis, Mo.
Offices and Stock Points in Principal Cities

SIZES UP TO 600 HORSE POWER

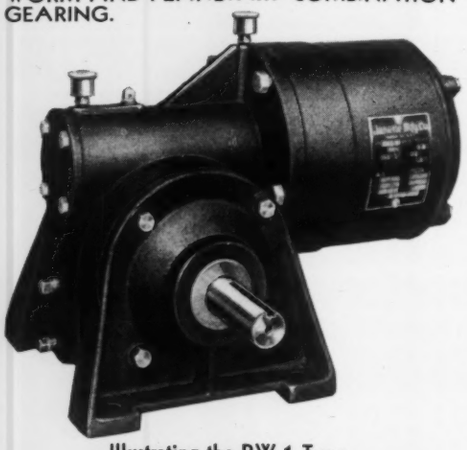
FOR NEVER-FAILING SERVICE
they chose ROLLWAY

Few services are tougher on bearings than deep well water pumping. Safety and health demand never failing service. That problem, plus increasing loads and high speeds, brought a leading maker of deep well pumps to Rollway. At the time no bearing of the size required for the length of service and load magnitude had been successfully operated at the speeds specified. The Rollway engineering staff worked out a solution based on Rollway principles of cylindrical bearing design, that has assured completely dependable operation. Bring your roller bearing problems to our engineering staff for analysis.

ROLLWAY BEARING CO., INC., SYRACUSE, N. Y.

Janette
MOTORIZED SPEED REDUCERS

16 DIFFERENT TYPES
1/50 to 7 1/2 H.P. RATINGS—FOOT—FLANGE—FOOT AND FLANGE MOUNTINGS . . . WORM—HELICAL—SPUR—WORM AND PLANETARY COMBINATION GEARING.



Illustrating the RW-1 Type
The diversity of the Janette custom built line of motorized speed reducers enables us to supply a machine for almost any purpose. Let our engineers help in selecting the right type for your application.

Rotary Converters—Generators—Motors—Motor-Generators
Janette Manufacturing Company
556-558 West Monroe Street Chicago, Ill. U. S. A.
BOSTON - NEW YORK - PHILADELPHIA - CLEVELAND - MILWAUKEE - LOS ANGELES
DETROIT - SEATTLE

sixth to one-half horsepower. Speed changes are accomplished by a three-point switch or automatic control, providing speed control for belted blowers, fans and similar installations. The motor operates at 1750 RPM and at 1150 or 850 RPM, according to the customer's specification.

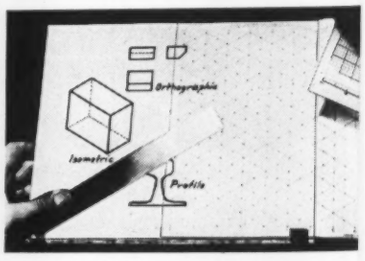
Plastic Possesses Extra Strength

FIVE times the impact strength of standard molding materials is claimed for a new phenolic plastic developed by General Plastics Inc., North Tonawanda, N. Y. Known as Durez 1590, the material has an impact strength of .7 (A.S.T.M.) and should find many industrial applications where greater resistance to shock is desired. It molds and performs easily, has a relatively low bulk factor and in molded form has a somewhat rippled surface.

Engineering Department Equipment

Tracing Set Aids Draftsman

SKETCHING is simplified for the draftsman by a small tracing paper pad set, sealed on three edges, brought out by Wade Instrument Co., 2246 Brooklyn Station, Cleveland. In addition to the tracing pad is a guide plate and steel straight edge. Isometric design in blue lines is printed on one side of the plate and on the other side are 8 by 8 lines with every ½ inch line heavy. The guide plate is moisture, dirt and crack-proof and may be easily cleaned. The sketch pad set comes in three sizes: 200 sheets, 5½ by 8½ inches; 100 sheets, 8½ by 11 inches, and 50 sheets, 11 by 17 inches.



Guide plate printed on one side with isometric lines and on the other with ruled lines aids draftsmen

Develops New Vibration Pick Up

VIBRATIONS as slight as those from the escapement of a wrist watch may be picked up with the new model 156 crystal vibration instrument

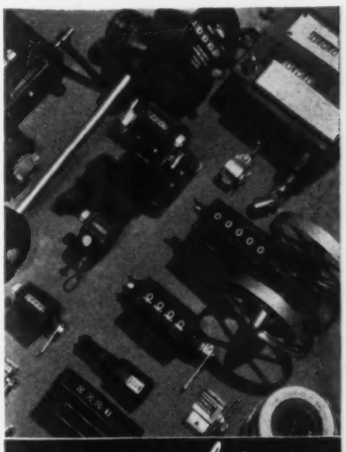
What can your product say for itself . . .

when a sale hangs in the balance?

Make your product sales-minded. Let it make a sales presentation of its own — with accurate performance facts and service records that show the prospect *exactly* what he, as a user, can expect.

These facts and records are being supplied now—by built-in Veeder-Root Counting Devices—on a wide variety of products such as business and amusement machines, trucks, elevators, dispensers, tractors, machine tools, presses. From the outset of service these built-in counters register starts, stops, pieces, trips, mileages, volumes, speeds, lengths.

Do you actually *know* whether or not a built-in counting device can increase the marketability of *your* product? It's well worth while finding out. Write.



Counters for Every Purpose

VEEDER-ROOT INC.

HARTFORD, CONNECTICUT

OFFICES IN BOSTON, CHICAGO, CINCINNATI, CLEVELAND, DETROIT, GREENVILLE, S. C., LOS ANGELES, NEW YORK, PHILADELPHIA, PITTSBURGH, ST. LOUIS, SAN FRANCISCO, MONTREAL, CANADA, BUENOS AIRES, MEXICO CITY, LONDON, PARIS, TOKIO, SHANGHAI, MELBOURNE

PULLMORE CLUTCHES

used in BARBER-COLMAN Type T Hobbing Machines

Pullmore Clutches are made in single and double types, for operation in oil or dry, in capacities up to 75 h.p.

Pullmore Clutches are used in the main drive of Barber-Colman Type T Hobbing Machines and in other machine tools, cranes, industrial trucks and similar equipment because these clutches are reliable, simple, compact, adaptable, durable and economical. Complete information on features, advantages, types and sizes supplied promptly on request—write for it today.

ROCKFORD DRILLING MACHINE DIVISION

Borg-Warner Corporation, 304 Catherine Street, Rockford, Illinois

Sold by MORSE CHAIN CO., Ithaca, N. Y. With offices in principal cities

»» **LARGE** or small—

Truly versatile, WILMINGTON VULCANIZED FIBRE is used for large gasket and tiny ratchet, alike . . . its broad properties fit it equally well for these—and a hundred thousand other applications.

A perfect insulator; tough; strong; light and attractive; hard, yet very easy and economical to fabricate . . . *it may be the one perfect solution to your problem!*

Your inquiry will bring you samples, prices, our Treatise on Fibre, and as much specific help as you want. Write, today!

WILMINGTON FIBRE SPECIALTY COMPANY

MANUFACTURERS OF GENUINE VULCANIZED FIBRE

WILMINGTON, DELAWARE

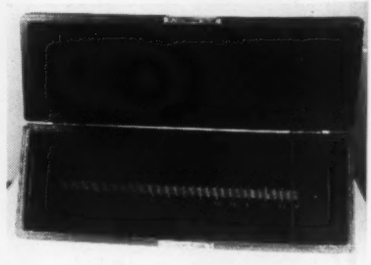
brought out by the Sundt Engineering Co., 4238 Lincoln avenue, Chicago. The bimorph crystal used in this model is mounted in an aluminum case and has no direct mechanical connection with the prod. When the case vibrates, the crystal flexes its own inertia and sets up voltage impulses of exactly the same form as the mechanical motion. The vibration pick up is used in connection with the model 150 oscil-

Vibration in machines may be easily located with the crystal pick up device

loscope which has a built-in amplifier and voltmeter on the output to determine the frequency, amplitude and velocity of vibration. Vibration study may be made with this apparatus on such machine units as electric motors, ball bearings, crankshafts, gear trains, fans and in reciprocating or rotating machinery of all kinds.

Glass Scale Aid to Draftsmen

DRAFTSMEN will find a new ruled glass scale placed on the market by Mico Instrument Co., Cambridge, Mass., an aid in many drawing and measuring problems. Three models are offered: An English one six inches long and ruled in thirty-secondths of an inch, a similar type but ruled in tenths of an inch and a metric model 15 centimeters long and ruled



Lines and figures on glass scale are easily visible because of a special chemical preparation

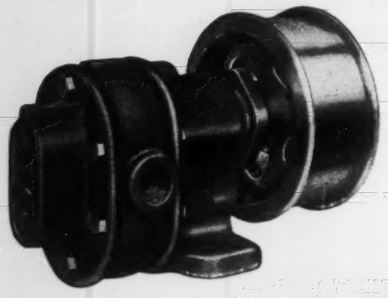
in millimeters. Lines and figures are ruled on a precision machine and filled by a chemical method that results in high visibility. Glass scales up to 40 inches in length can be made to order.

. . use Boston stock worms and worm gears

Because we must make all of our stock products to meet the specifications of our most exacting customers, you are always assured of obtaining a quality product when you specify Boston Stock Worms and Worm Gears. Our Catalog 51 lists all of the stock worms and worm gears that we manufacture. Write for your free copy today.

BOSTON GEAR WORKS, INC.
NORTH QUINCY, MASS.

Use *HELICAL GEARED* Pumps for — High Speeds — Quietness



Nos. 1S-2S-3S

—a new design with renewable bearings that permits operation at usual motor speeds.

Nos. 53-55

—a ball bearing pump giving large volumes at high pressures for supplying oil for hydraulic operation of machinery.

Brown & Sharpe Mfg. Co., Providence, R. I.

BROWN & SHARPE PUMPS

BS

Books in Popular Demand

Gear Design Simplified
By Franklin D. Jones $3.00

Handbook of Engineering Fundamentals
Edited by Orvid W. Eshbach.....$5.00

Ingenious Mechanisms for Designers and Engineers, Vol. II
Edited by Franklin D. Jones.....$5.00

Procedure Handbook of Arc Welding Design and Practice
Published by Lincoln Electric Co...$1.50

Materials of Engineering
By Herbert F. Moore $4.00

Corrosion Resistance of Metals and Alloys
By Robert J. McKay and Robert Worthington $7.00

Add 15c for postage

Available from

MACHINE DESIGN
Penton Building, Cleveland, Ohio

MEETINGS *and* EXPOSITIONS

June 21-24—

American Society of Agricultural Engineers. Annual meeting to be held in Urbana, Ill. Raymond Olney, St. Joseph, Mich., is secretary.

June 21-July 16—

Massachusetts Institute of Technology. Special summer school and conferences on "Strength of Materials," to be held at Massachusetts Institute of Technology, Cambridge, Mass., for four weeks beginning June 21. Prof. John M. Lessells, Department of Mechanical Engineering, Massachusetts Institute of Technology, is director of the summer school.

June 24-26—

American Society of Heating and Ventilating Engineers. Semi-annual meeting to be held at the New Ocean House, Swampscott, Mass. A. V. Hutchinson, 51 Madison avenue, New York, is secretary.

June 28-July 2—

American Society for Testing Materials. Annual meeting and exhibit to be held at Waldorf-Astoria, New York. C. L. Warwick, 260 South Broad street, Philadelphia, is secretary.

June 25-26—

American Society of Mechanical Engineers. Applied Mechanics meeting to be held jointly with hydraulic division of the A.S.M.E. under auspices of the Cornell university section of the society, at Willard Straight hall. Additional information may be obtained from Prof. F. G. Switzer, chairman, local committee, College of Engineering, Cornell university, Ithaca, N. Y.

June 29-July 2—

Society for the Promotion of Engineering Education. Mechanical engineering division to hold conference in Cambridge, Mass., to consider various phases of mechanical engineering. Conference to be held June 28 and 29, preceding annual meeting of the society. Prof. Frank L. Eidmann, Columbia university, New York, is chairman of the conference.

Inertia Forces Must Be Known

(*Concluded from Page* 49)

that the error in frame torque by use of the approximate method is small, even when considering one cylinder only. When considering the 6-cylinder engine as a whole, the error becomes much less. It can easily be shown that in the case of the conventional 6-cylinder engine the harmonics of an order exactly divisible by three are unbalanced, namely: The third, sixth, ninth, etc. Hence only the "3θ" harmonics of *Figs.* 3 and 5 need be taken into consideration.

Crankshaft Torque Correction Very Small

By use of the approximate inertia torque curve of *Fig.* 5 and the corrections indicated by *Fig.* 3 a corrected crankshaft torque curve might be drawn. However, even considering only one cylinder the corrections for crankshaft torque are so small as to make the two curves almost coincident. This indicates that the approximate method gives quite accurate results as far as the crankshaft torque is concerned. Furthermore, when six cylinders, instead of one, are considered, there is no visible error from *Fig.* 3 because there is no "3θ" harmonic.

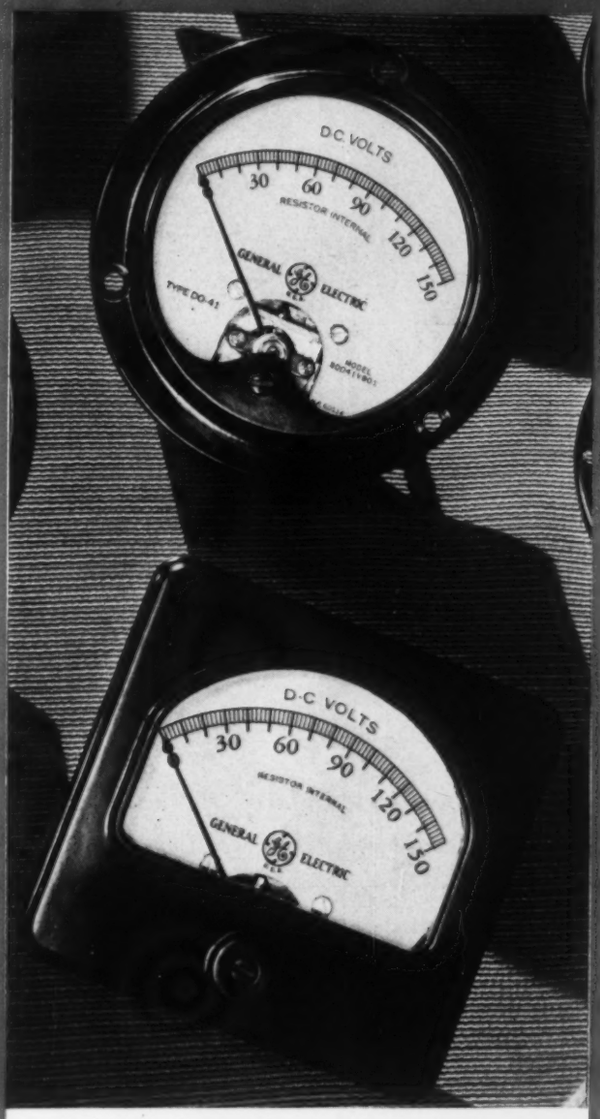
As a result of the above calculations we may conclude that, for a single-cylindered engine, the use of the customary approximate method of treating the connecting rod inertia: (a) Produces no error in calculation of unbalanced inertia forces; (b) Introduces a negligible error in the rotative inertia couple acting on the crankshaft; (c) Introduces a considerable error in the "reaction" couple on the engine frame.

More Cylinders Reduce Unbalance

In the multicylindered engine the inertia torques caused by the reciprocating parts of various cylinders tend to balance one another, the degree of balance depending upon the crankshaft design and cylinder arrangement. Similarly, in the multicylindered engine the corrective crankshaft and frame torques as calculated by equations (10) and (11) are composed of harmonics, some of which balance one another. It follows therefore that the multicylindered engine has less unbalanced torque to start with and the corrections also are smaller, as compared with a single-cylindered engine. For example, in a 4-cylinder engine of conventional design, the unbalanced harmonics of inertia torque are those of orders which are divisible by 2, namely, 2θ, 4θ, 6θ, etc. In 6-cylinder engines harmonics of orders divisible by 3 only are unbalanced (3θ, 6θ, etc).

As no error in unbalanced forces can be attributed to the use of the approximate method, this method causes no error in lateral or "rocking" couples caused by such forces, where the cylinders are in different planes.

IT PAYS
to Build G-E Instruments into Your Machines



IT HAS PAID other manufacturers and it will pay you to specify G-E instruments on your machines. Our engineers will be glad to modify a standard instrument to meet your requirements. Or, if you have unusual problems, they will work out a new design.

Why not take advantage of the G-E facilities and make General Electric your

Headquarters for Electrical Measurement

430-62

GENERAL ELECTRIC

PHOTOELECTRIC MEANS AUTOMATIC

Compact, inexpensive, easily installed K1 relay

IN modern machine design, automatic operation is ordinarily provided wherever possible. Automatic operation is easy to obtain with a G-E photoelectric relay, since merely interrupting or varying the intensity of a beam of light can be made to actuate the control.

Photoelectric Relays for Every Job

The dozens of different types of photoelectric relays—self-contained units, and units with separately mounted phototubes—enable the designer to obtain almost any speed or sensitivity that he desires. Simple, compact, and easily adjusted, they are excellently suited to machine-tool use.

Why not write today for information on the many types of photoelectric relays and their applications? This information will help you to select *exactly the right relay* the next time you have a problem of automatic operation. General Electric Company, Schenectady, N. Y.

080-126

GENERAL ELECTRIC

Noteworthy Patents

(*Concluded from Page* 64)

skag slides over it, automatically raising propeller and rudder out of harm's way.

The frame can be raised by means of a cable fixed to the top of the tube and running over a pulley into the hull of the boat. Thus the driving mechanism can be lifted entirely out of the water when the boat is not in use, thereby preventing corrosion and enabling easy inspection and repair.

Mr. Svendsen's patent, in which he has assigned a half interest to David G. Chandler of Minneapolis, carries the number 2,076,603.

AN INTERESTING linkage of equalizing type is covered by patent No. 2,076,766. Developed by Philip Franklin of King's Cross, London, England, and assigned to the Westinghouse Air Brake Co. of Wilmerding, Pa., this mechanism makes possible the application of brake shoes to adjacent drive wheels of a locomotive, even when the wheels are very close together, as now is generally the case.

Two variations of the linkage are shown in *Fig.* 3. the draw bar pull in each case being in the same direction, the difference being in the location of the short pivoted link to which the drawbar is connected.

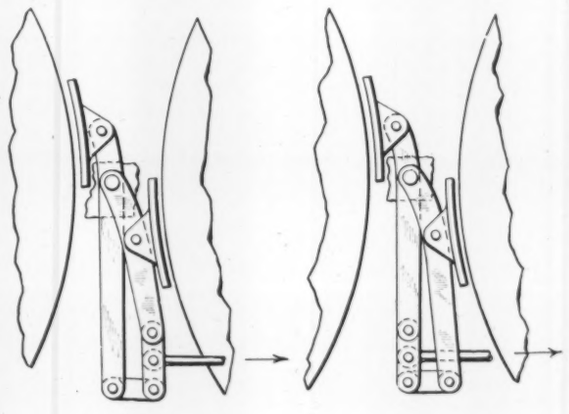


Fig. 3.—*Compact linkage gives equalized pressure to brake shoes on locomotive drive wheels*

It will be noted that in either case the main levers are so proportioned and the brake shoes so mounted thereon that not only is considerable leverage exerted but also that the pressure on each shoe is approximately the same. Either of the systems can be used in reversed position if desirable, that is with the long arms above the fixed pin instead of below as shown.

MANUFACTURERS' PUBLICATIONS

ALLOY (NICKEL)—Machining properties and related information on Monel, Inconel and nickel is contained in bulletin T-12 issued by the Development and Research Division, The International Nickel Co., Inc., 67 Wall street, New York.

ALLOYS (NICKEL)—Wire cloth made of Monel metal is the subject of a bulletin issued by The International Nickel Co., Inc., 67 Wall street, New York. The bulletin contains illustrations of wire cloth applications for screen and filter purposes and describes different weaves of metal mesh.

BEARINGS—Drawings of ball bearings for layout work are offered by New Departure, Division of General Motors, Bristol, Conn., in a set of 19 sheets prepared for engineers, designers and draftsmen. The sheets will be mailed free to all who request them.

BEARINGS—In a recently issued circular, "Ball Bearings for Spinning Frames," Fafnir Bearing Co., New Britain, Conn., describes the exclusive features of Fafnir spinning frame boxes.

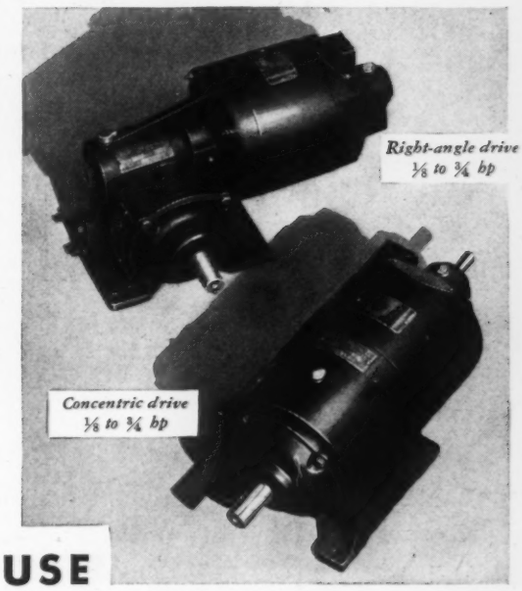
CHAINS—Roller chain and sprocket catalog 607 has just been published by Diamond Chain & Mfg. Co., Indianapolis and contains complete information and prices on standard roller chains from ⅜-inch pitch to 2-inch pitch.

CHAINS—Baldwin-Duckworth Chain Corp., Springfield, Mass., has released bulletin 59 on types and specifications of non-corrosive and heat-resistant chains. A table is included showing the degree of resistance to different corrosive agents.

CONTROLS (ELECTRICAL)—Two bulletins, 5601 and 5602, issued by Ward Leonard Electric Co., Mount Vernon, N. Y., describe and illustrate regulators recently developed by the company. Bulletin 5601 explains the operation of an electronic regulator and 5602 describes a model designed for only one scheme of excitation.

CONTROLS (ELECTRICAL)—Bulletin G-14, published by Automatic Temperature Control Co., Inc., 34 East Logan street, Philadelphia, shows several types

HOW TO SAVE SPACE AND REDUCE ASSEMBLY COST



USE

G-E FHP GEAR-MOTORS

Efficient, low-speed drives. Require only slightly more space than standard motors, and are as easily and quickly mounted. Reduce installation and maintenance expense. Combine the economy of high-speed motors with that of accurately cut, enclosed gearing. Motors and gears permanently aligned. Long-lived, self-contained units—quiet, clean, and safe.

Gear-motors can be direct connected, or used on belt, chain, or gear drives. Right-angle drives are available in constant-speed ratings from 197 to 5.7 rpm, and concentric drives from 575 to 12.5 rpm. Thousands are now in service on conveyors, mixers, machine tools, and the like.

In addition to the fractional-horsepower units shown above, General Electric makes a complete line of gear-motors in integral ratings up to 75 horsepower. For further information, write General Electric, Schenectady, N. Y.

Consider G-E Performance, Convenience, Service.

070-202

GENERAL ELECTRIC

FLAMENOL

NOW OFFERED

to the manufacturer of electrically driven equipment whose wiring must stand extraordinary conditions

FLAMENOL is a new, synthetic, rubber-like compound that is radically different from any heretofore available. It has practically all the qualities required in a cable insulation and finish.

- Flamenol is flameproof. It is highly resistant to moisture, acids, alkalies, and oil. It has remarkable long-aging qualities, and is also strong dielectrically and mechanically. For the time being, however, its use is limited to 600-volt service.
- Investigate Flamenol cable for the wiring of high-grade equipment — such as machine tools — for battery, coil, and motor leads — and for any use where its properties are the only ones that fully meet conditions.
- But *note*: Flamenol insulated cable costs more because it does more. Yet it may be the answer to many a wiring problem that has long been troublesome, and our engineers will gladly work with a manufacturer to determine if Flamenol is that answer. Address nearest G-E sales office, or General Electric, Dept.6A-201, Schenectady, N. Y.

520-114

GENERAL ELECTRIC

of automatic timers.

CONTROLS (ELECTRICAL)—Fundamental differences between the solenoid-type motor-starter and the conventional clapper-type starter are explained in a 24-page, two-color booklet released by The Allen-Bradley Co., Milwaukee.

CONTROLS—(ELECTRICAL)—Bulletin GEA-821 F superseding bulletin GE-821 E describes pressure and vacuum switches, CR2927, diaphragm type, manufactured by General Electric Co., Schenectady, N. Y. Graphs showing operating characteristics are included.

DRIVES—Couplings and pulleys, including variable speed and stepped-cone types, are described in a four-page bulletin issued by Congress Tool and Die Co., Detroit. Prices, weight, shaft sizes and keyway data are covered in the bulletin.

DRIVES—The latest edition of the Reeves handbook, prepared by the Reeves Pulley Co., Columbus, Ind., and covering all phases of variable speed control has been printed. The 118-page booklet also gives specifications for Reeves variable speed units.

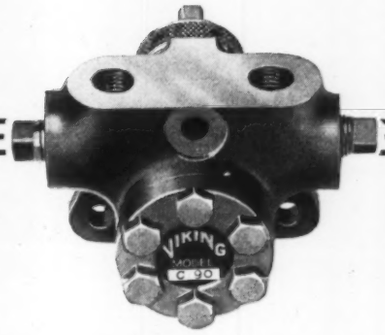
FASTENINGS—The Russell, Burdsall & Ward Bolt and Nut Co., Port Chester, N. Y., has just published a small handbook which shows the correct method for drawing and dimensioning nuts and bolts. It consists of 20 pages, and is small enough to fit the average drawing case.

FILTERS—Air-Maze Corp., 812 Huron Road, Cleveland, in their catalog NIND-37 describes the construction and gives specifications of their new oil-bath type filters. A price list is included in the catalog.

INSTRUMENTS—Design, specifications and applications of spectrometric equipment are given in catalog D-221 issued by Bausch & Lomb Optical Co., Rochester, N. Y. Equipment for spectrophotometry is also described.

PUMPS—Ingersoll-Rand Co., 11 Broadway, New York, has prepared a catalog describing its Cameron motor-pumps. Pump capacities range from five to 1000 gallons per minute and motor sizes are from ¼ to 40 horsepower.

SPRINGS—"How to Design Flat Springs to Meet Definite Requirements" is the title of a booklet just off the press, prepared by the Research department of the Beryllium Corp. of Pennsylvania, Reading, Pa. Formulas, illustrations of spring types and sample calculations are given as well as comparisons of spring materials.

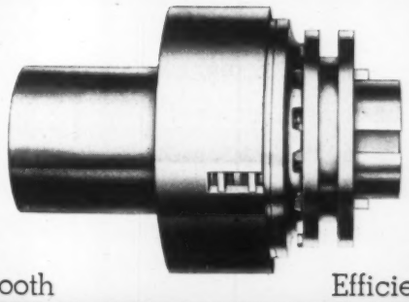


FLEXIBLE... Easily installed..designed and built for maximum pressures of several hundred pounds on lubricating liquids.. suitable for direct connection to power and direct flange connection to machine.

Truly a FLEXIBLE pump.. another Viking Unit that can give you greater service.. greater operating economy. Write for bulletin and prices.

VIKING PUMP CO.
CEDAR FALLS, IOWA

CONWAY Sleeve Clutch



Smooth Efficient

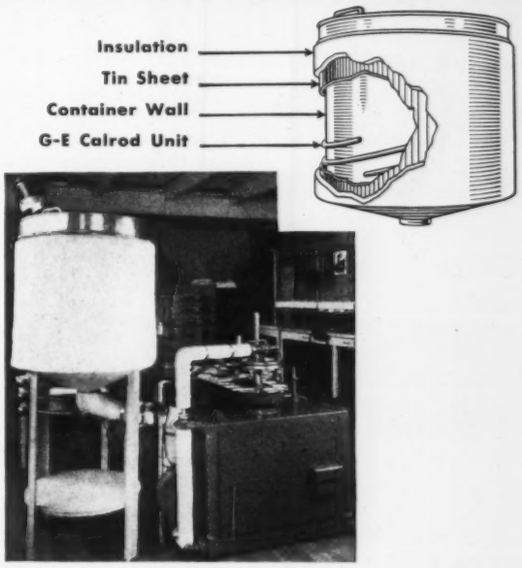
Designed for restricted swing radii and fractional horse powers, all the desirable qualities for which Conway clutches are famous are incorporated in this new Sleeve Clutch—full floating plates, high ratio leverage, easy engagement, instant release and free idling. Also built to operate double throw.

Write for More Information.

THE CONWAY CLUTCH CO.

1546 Queen City Avenue
CINCINNATI, OHIO

ELECTRIC HEAT
MAKES BETTER PRODUCT —AND MORE SALES



IMPROVED packaging made possible by electric heating units built into the packaging machine increased, by leaps and bounds, the sales of the E. W. Rose Company, Cleveland, manufacturer of Zemo ointment.

Zemo is solid at ordinary temperatures; when heated, it flows and neatly fills the containing tins. The ointment must be sterile; when handled with electric heat, it remains clean and pure.

General Electric Calrod heating units, built into the walls of the batch container and applied to the pipes that carry the ointment to the filler heads, maintain the proper temperature. Being built in, they are neat; and being electric, they are easily controlled.

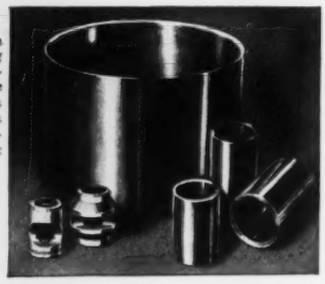
The old method of packaging consisted of a cold fill and had a tendency to smear the containers and lids. The new method makes a clean fill and leaves the package unsoiled. Sales have increased as a result.

G-E heating units may prove an inexpensive and convenient means of applying heat to your machines. For information, write to the nearest G-E sales office or to General Electric Company, Schenectady, New York.

160-49

GENERAL ELECTRIC

Compared with rough cast bars, Bunting Machined and Centered Bearing Bronze Bars save more than the metal costs in set-up and machining time. 131 stock sizes.



Do as so many others do—buy bearings as you need them—let Bunting carry the stock.

Over 600 different sizes of bearings you most frequently require are available instantly in any quantity at any time, completely machined and finished ready for assembly.

Bearings for service replacement in electric motors of all makes and models from 1/40 hp to 60 hp are obtainable from stock as needed.

Write for one or more copies of the Bunting Catalog that takes the place of an expensive inventory in thousands of plants throughout America today . . . The Bunting Brass & Bronze Company, Toledo, Ohio. Branches and Warehouses in All Principal Cities.

BUNTING Quality

BRONZE BUSHINGS · BEARINGS
MACHINED AND CENTERED BRONZE BARS
BABBITT METALS

Business and Sales Briefs . . . . . .

HARRY F. VICKERS has been elected president of Vickers Inc., Detroit, which recently became part of the Sperry Corp., New York. The management of the company will continue as in the past and with no changes in policy.

* * *

Syntron Co., Pittsburgh, has moved all machinery, equipment and inventory, and its general offices, to its new plant in Homer City, Pa., from which plant all operations will be conducted as of June 1.

* * *

Maas & Waldstein Co., Newark, N. J., makers of industrial finishes, has appointed Floyd M. Erlenmeyer as its western New York representative, with headquarters at 253 Alexandria street, Rochester, N. Y.

* * *

W. A. Jones Foundry & Machine Co., Chicago, manufacturers of speed reducers, gears, and transmission appliances, has announced that its Buffalo, N. Y., office, in charge of Frank W. Stuker, is now located at 361 Delaware avenue, in the Curtiss building.

* * *

Ex-Cell-O Aircraft & Tool Corp., Detroit, has changed its name to Ex-Cell-O Corp. The company also announces that Williams and Wilson, Ltd., 544 Inspector street, Montreal, Canada, is its representative in that territory.

* * *

According to a recent announcement, Huey & Philp Hardware Co., with warehouses at Dallas and Houston, Texas, and Star Steel Supply Co., 7522 Oakland street, Detroit, have been appointed distributors of Enduro stainless steel, manufactured by Republic Steel Corp., Cleveland.

* * *

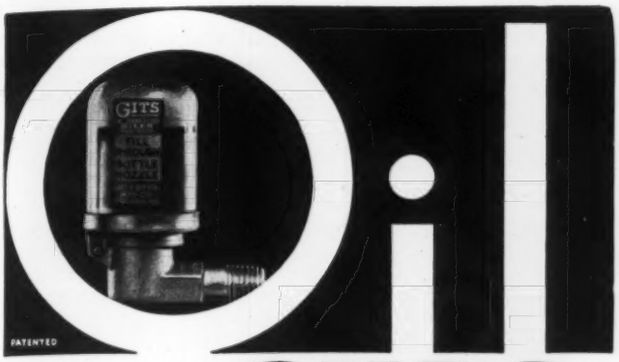
William Ufer and Walter Lischett have been transferred to the sales department of The Mercoid Corp., 4201 Belmont avenue, Chicago, after a training period in the factory and several years as service men on the company's automatic controls for heating, air conditioning, refrigeration and industrial applications.

* * *

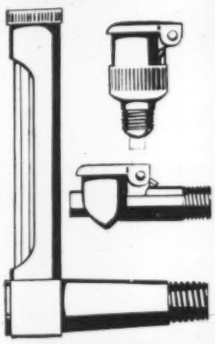
A new field service station policy has been established by the Emerson Electric Mfg. Co., St. Louis. Forty-one firms have been appointed authorized service stations for their respective territories to handle all repairs on motors, either within or beyond the guarantee period. A list of these firms will be furnished upon request

* * *

Opening of a new direct factory branch office at 881 Massachusetts avenue, Indianapolis, has been announced by Viking Pump Co., Cedar Falls, Ia. Clifford D. Sadler, formerly manager of the small pump division, will be in charge of sales and service for the state of



Oil CUPS



Seven hundred styles and sizes — to fill any industrial requirement — is proof of Gits leadership. The Gits line includes a complete range from regulation oil hole covers to special feature oilers — unbreakable sight wick feed, gravity feed or constant level oilers — oil cans — oil and grease seals and gauges. General catalog includes illustrations and complete information on all styles.

GITS BROS
MANUFACTURING CO.
1861 S. KILBOURN AVE., CHICAGO

As vital as the racquet to tennis!

ROPER
PUMPS
FOR METAL WORKING MACHINES

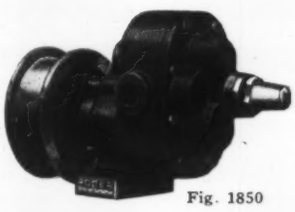


Fig. 1850

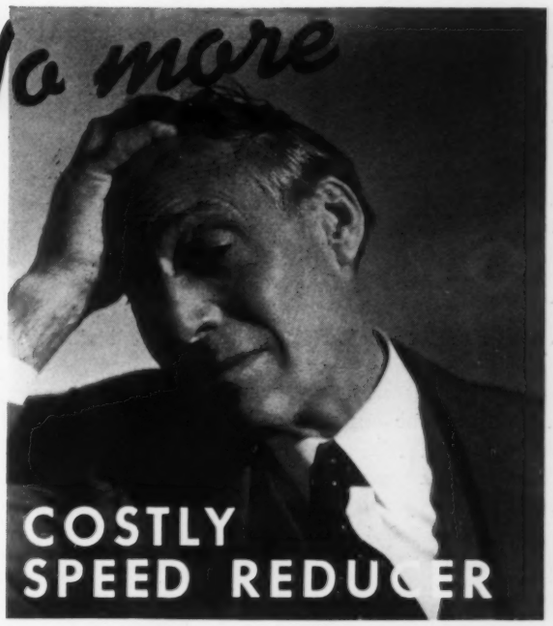
Roper Non-Pulsating Coolant Pumps handle cutting compounds and lubricating fluids with power to supply the deepest bores and cuts. Guaranteed not to lose prime . . . high or low pressure, delivering 1 to 20 G.P.M.

Roper Pumps . . . dependable since 1857 . . . are your best guarantee of uninterrupted service from metal working machines.

Write for Bulletin R4MD.

GEO. D. ROPER CORP., ROCKFORD, ILL.

No more



headaches

Production tie-ups—frequent maintenance complaints and disgusted customers too frequently come from "anonymous" speed reducers.

Leave it to IXL gear engineering specialists with 76 years of experience in designing and producing quality gears to end costly speed reducer headaches. The reputation of your products is safe with IXL speed reducers or gears.

In the largest exclusive gear plant in the world, great modern gear cutting tools, unequalled skill, and rigid inspections assure prompt deliveries and uniform quality no matter what type of gear requirement. Over 100,000 hobs, cutters and patterns are available. Our engineers will gladly cooperate.

IXL
The Mark of Quality

FOOTE BROS.
GEAR & MACHINE CORPORATION
5303 S. Western Boulevard - Chicago

• *A Complete* IXL *Line* •

Speed Reducers	*Combinations*	*Powered Gears*
Worm	*Gears of all kind*	Helical Type
Helical	Metallic	Radiating Worm
Herringbone	Non-Metallic	Gear Type

Stoker Drives • Friction Clutches
Couplings

Special Machinery of all kinds
Helical Oil Well Pumping Units
Vertical Deep Well Pump Drives
Vertical Agitator Mash Tub Drives

FREE

FOOTE BROS. GEAR & MACHINE CORP., Chicago, Illinois

Please mail me, without obligation, your 600-page book, "Gear Problems."

*Company*_____
*Address*_____
*My Name*_____
*Title*_____